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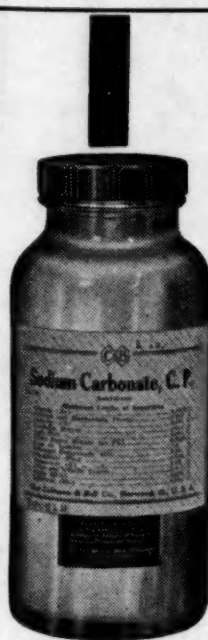
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DROSOPHILA AND SPECIATION¹

By Dr. J. T. PATTERSON

PROFESSOR OF ZOOLOGY, UNIVERSITY OF TEXAS

ONE of the duties of the office of vice-president, if not the only one, is that of giving the address on the occasion of the annual Zoologists' dinner. Examination of a number of the papers which have been read by my predecessors in office shows that the speaker has entire freedom in the selection of his subject and the method of its presentation. The several addresses which were examined deal with various topics, with some enlivened by much subtle humor and others revealing evidence of serious efforts to plumb the depths of the philosophy of biology. For me it seems safer to pursue a middle course.

¹ Address of the retiring vice-president and chairman of the Section for the Zoological Sciences of the American Association for the Advancement of Science, Dallas, Texas, December 30, 1941.

I have selected for discussion a subject which, although venerable, is still capable of holding the attention of biologists. It is now more than eighty years since Charles Darwin posed the question of the origin of species, but until recently we did not have experimental proof of the exact method by which a given animal species might have arisen among wild populations. Following the appearance of Darwin's classical work, and prior to the development of the modern theory of Mendelian inheritance, most investigators were concerned with the problem of establishing the fact of evolution. They used largely the descriptive methods of comparative anatomy, embryology, paleontology and taxonomy coupled with geography. All this work was fundamental and im-

portant, but it left the main question raised by Darwin's conclusions still unanswered as it did not elucidate the *modus operandi* of species origin and differentiation.

This was the situation at the turn of the century with reference to the origin of species. Then, with the rediscovery of Mendelism, there followed a very rapid development in the fields of cytology and genetics, with the early deduction that chromosomes and hereditary factors could be definitely correlated. The final triumph of this deduction was brought about through the investigations of Morgan and his co-workers on the most common of the fruit-flies, *Drosophila melanogaster*. These studies resulted in the erection of a complicated system of genetic research which centers on the gene as the determiner of hereditary characters. As the system became more and more complicated, the fear or the hope, depending on the outlook of the commentator, was expressed that the whole structure was in danger of falling of its own weight; but, like the Leaning Tower of Pisa, it still stands.

The technical methods developed in connection with this work on *Drosophila* are indispensable for an analysis of the problem of the origin of species. In recent years two additional technical advances have been made which are of great importance. The first of these was Muller's demonstration that x-rays could be used as a means of inducing mutations and chromosomal rearrangements, and at a rate far exceeding that which occurs in untreated organisms. This method has made it possible to study in great detail various kinds of rearrangements, such as translocations, inversions, duplications and deficiencies, and has resulted in enriching our knowledge of the effects of such changes on genotype and phenotype.

The second advance was made by Painter's development of the salivary-gland chromosome technique and his demonstration that the bands of these giant elements precisely follow the sequence of loci of known mutant genes as revealed on the "genetic maps" of *Drosophila*. This technique is a very rapid and convenient method for detecting changes in chromosome structure, whether they have been produced by artificial means or have occurred spontaneously in wild populations.

Coincident with this development of technical methods, there has occurred a rapid advancement in the application of mathematics to the problem of evolution. In this connection the work of Professor Sewall Wright, in showing some of the evolutionary consequences of Mendelian inheritance, is especially noteworthy.

In the meantime, some very interesting investigations have been made on the relation of environment

to evolution, especially on plants, which are more suitable for such studies than are most animal forms. Time will not allow for more than a brief reference to a recent publication by Clausen, Keck and Hiesey.² They experimented with a large number of the higher plants, selected from among many unlike species and families and taken from a wide range of habitats.

Their main experiment consisted in dividing the clone and planting the clone members in three different habitats or experimental gardens, located respectively at elevations of 100, 4,600 and 9,000 feet, in a transect across the central part of California. Here the plants were allowed to grow for several years and the changes arising in them under the different environmental conditions were noted and recorded. The first of their several general conclusions is as follows:

The individual plant is subject to the interplay between heredity and environment. When grown under different environments it may be quantitatively changed in various degrees. The changes induced by a new environment give no evidence of permanence, but have been shown to be reversible modifications. Some of these changes in vegetative characters are quite spectacular, yet they never obscure the individuality of the plant, which is retained irrespective of the conditions of altitude, light and moisture in which the plant is grown.

This work shows that while environmental factors can induce modifications in phenotype, yet they do not change the genotype. It is clear that attempts to solve the problem of the origin of species must be attacked by genetic and cytological methods in a sexually reproducing diploid organism like *Drosophila*.

MATERIAL REQUIRED FOR THE PROBLEM

The series of technical methods outlined above are chiefly genetic and cytological in character and constitute a set of tools with which to attack the problem of speciation. But after all, they are tools and other requirements must be met if the problem of the origin of species is to be satisfactorily solved. One of the most important of these is the choice of material. The group of organisms selected for study should, among other requirements, meet the following conditions:

First, they should belong to a genus with many species living under a variety of environmental conditions and capable of being cultured in the laboratory. They should also be amenable to detailed genetic analysis, so that quantitative data on their genic differences can be obtained. Short life cycle and high fecundity are other desirable traits.

Second, the group selected should possess a relatively low number of chromosomes, and these should be large enough to permit accurate study and analysis. The dense metaphase chromosomes, usually de-

² Carnegie Inst. of Wash. Pub. No. 520, 1940.

void of any distinguishable morphological features, are not satisfactory.

Third, the several species should not only occupy different ecological niches, but they should also exhibit a wide range of conditions of size, density and distribution of their populations. Otherwise, it would not be possible to test the relation between population type and genic variation.

Fourth, some of the forms within the group should be capable of producing hybrids, and at least some of these hybrids must be fertile, in order that the genetic mechanism underlying their isolation and differentiation can be determined. This last condition is not easy to realize among animal forms.

The group of forms which would seem to meet all these exacting requirements is to be found in the genus *Drosophila*. It is for this reason, perhaps, that several different workers have recently become interested in this line of investigation, especially Sturtevant, Dobzhansky, Spencer and our own group here in Texas.

It seems surprising that work of this nature on the genus has been so long delayed, but this is due undoubtedly to a failure to secure fertile hybrids at an earlier time. As late as 1934 only two cases of hybrids had been reported. The first of these was found by Sturtevant in 1920 and involved crosses between *D. melanogaster* and *D. simulans*, two closely related species. Unfortunately the hybrids from this cross are completely sterile. The second case of interspecific hybridization in the genus was not found until nearly a decade later (1929), when Lancefield reported that *D. pseudoobscura* was represented by two races or physiological species. He found that crosses between these two races produce partially fertile females and sterile males. Since then, and especially during the last few years, the number of cases of fertile hybrids in the genus has gradually been increased, so that the lack of such hybrids is no longer a handicap.

DROSOPHILA IN THE SOUTHWEST

We had reasons for supposing that southern United States, and especially the southwestern area and northern Mexico, would be an excellent region in which to collect *Drosophila* species for use in the study of this problem. Accordingly, in 1938 we began collecting the wild strains in Texas, and since then have covered most of the southern states and parts of northern Mexico. To date this region has yielded a total of 97 species of the subfamily *Drosophilinae*. Twelve of these species belong to non-*Drosophila* genera and will not be considered further. Of the 85 species belonging to the genus *Drosophila*, 81 came from the Southwest and northern Mexico.

A detailed morphological study of these 85 species

makes it possible to arrange a large majority of them into natural groups or "species groups," each composed of two or more closely related forms. Through such studies we have established twelve species groups which include 67 species. Thus far we have not found a closely related form for any of the eighteen unassigned species, but it is probable that further collecting in this and other areas will bring to light some such forms.

I am emphasizing the groups because they constitute the material units within which the tests for species origin must be made. Indeed, it is within the group that one may expect to find the production of hybrids. Cross tests carried out between species selected from different groups have thus far failed to produce hybrids, and this is true even when the forms used for the test come from groups obviously closely related. Moreover, various types of population are to be found in different species groups, such as those with dense populations as compared with those having sparse populations. Again, the members of some groups have small, dense populations with wide-spread distribution. All these different types must be thoroughly studied if faulty conclusions are to be avoided.

The groups are also important for purposes of chromosome analysis. The fact has long been known that the basic diploid number for the genus is twelve, consisting of five pairs of rod-shaped elements and a pair of small chromosomes which are usually referred to as dots. One notable characteristic in some groups is that the X chromosomes are distinctly longer than the autosomes, and that the Y chromosome may vary in size and shape—from a short to a long rod, or from a J to a V. Within the groups, variations in the number of arms in metaphase have been found to be due either to a fusion of two rods, or to an inversion or insertion which has shifted the centromere from its position close to the end to one nearer the middle. This results in changing the chromosome from a rod to a J- or V-shaped element. My co-worker Griffen has found that this is true for all cases thus far examined for any given group.

Within the group, where hybrids are obtainable, the salivary chromosome furnishes the only means whereby a highly detailed analysis and comparison of chromosome organization can be made between different species. The structural features of these elements make it possible to use them as tracers in following out the distribution of a particular chromosome or its parts within the population, like the use of radioactive tracer atoms in following out the distribution of substances within the body. This method has been used by Sturtevant and Dobzhansky in their studies on *pseudoobscura* and *miranda* and we have extensively employed it in our own work.

Some of the twelve species groups have been investigated in other laboratories. We have been working on seven of them, and they furnish considerable material upon which to base some general conclusions concerning the origin of species in the genus *Drosophila*. To make this clear it will be necessary to refer again to some of the facts given in my symposium address, but these repetitions will be reduced to the minimum.

If mutational changes lie at the basis of organic diversity, it should be possible to demonstrate the mechanism involved through suitable tests and careful cytological observations. Unless the genetic mechanism of organic evolution is to remain a mere hypothesis, it will be necessary to do this on wild populations. Various questions have been raised concerning the nature of this mechanism. Our own studies afford answers to some of these questions.

One of the essential differences between animal species is the fact that they usually do not attempt to cross. This reluctance or refusal to mate has been termed sexual isolation. Our results show that this type of isolation is due to genetic factors which operate both between species and within a species. In the single species, *Drosophila repleta*, Wharton has made cross tests with strains collected at different points in Texas, Eagle Pass, Elgin, Fredericksburg and Galveston, and with stocks from New Haven, Connecticut, Guatemala, Central America, and Ankara, Turkey. Her results show that while matings between certain strains either fail to go or go very rarely, yet the reciprocal crosses are very successful, producing offspring which are highly viable and fully fertile. A few examples may be cited.

The cross between Ankara males and either Fredericksburg or Guatemala females is practically sterile, while the reciprocal crosses are highly fertile. Again, New Haven males are sterile to Fredericksburg and Guatemala females, but fully fertile to Eagle Pass and Elgin females. In the reciprocal crosses, New Haven females are fully fertile to Fredericksburg and Eagle Pass males, slightly fertile to Guatemala males and sterile to Elgin males.

The failure to produce offspring in many of these crosses is due to sexual isolation. This was proved by examinations of the reproductive tracts of the females, which in no case of cross-sterile matings contained sperm. If successful mating has occurred, sperm can always be detected. A study of the salivary-gland chromosomes of the F_1 larvae shows that the sterility is not associated with major chromosomal rearrangements. The complexity of the cross-sterility relations indicates that sexual isolation depends on different factors in the several strains. These factors are autosomal recessives because the heterozygotes are fully

fertile and exhibit hybrid vigor. Despite this isolation, the different strains can not be regarded as separate species. This same type of isolation has been encountered in all the species groups which we have studied, and in the virilis group at least some of them are also due to autosomal recessive factors.

While sexual isolation must play an important rôle in species differentiation, yet it is doubtful whether it alone would be a sufficient mechanism. There is always the possibility that this barrier to crossing might occasionally break down and thus permit an exchange of genes within the population. It was therefore not surprising to find additional isolating mechanisms present within differentiating species groups.

THE MACROSPINA GROUP

A very fine example of multiple mechanisms in operation is to be seen in the macrospina group. There are at least four detectable mechanisms present in this group. These are sexual isolation, hybrid sterility, a sex chromosome unbalance and the passive factor of geographical separation. Geographically, the several forms may be separated into three divisions. In California there is a single species which has been described by Spencer as *Drosophila subfunnebris*. The second divisional group is composed of a series of strains taken in Sonora, Mexico, southern Utah, Arizona, New Mexico and west Texas. The numerous strains probably all belong to a single subspecies of *D. macrospina* which is known as *limpiensis*. The third divisional group is composed of another series of strains which have been taken from central Texas eastward to Florida and northward to Ohio. These strains may also constitute a single subspecies known as *D. macrospina macrospina*, although Spencer regards the Ohio strains as different from the type material from Texas and has designated them as the subspecies *ohioensis*. The three groups will be referred to as *subfunnebris*, *limpiensis* and *macrospina*.

If a series of cross tests be carried out between the different members of this group by starting with *subfunnebris* of California and progressing eastward, a very interesting set of facts become revealed. The cross between *subfunnebris* and its nearest *limpiensis* neighbor in Utah goes rather readily in both directions, producing fertile female hybrids and sterile male hybrids. In matings of *subfunnebris* to a New Mexico strain of *limpiensis* the cross again goes both ways, but owing to the operation of sexual isolation, it takes twice the normal time of ten days for the larvae to appear in the culture when *subfunnebris* is used as the female parent. The cross between *subfunnebris* and a strain of *limpiensis* from west Texas

goes but one way, producing only a few progeny and requiring from twenty-five to thirty-five days for the larvae to appear. Finally, in the cross between *subfunnebris* males and *macrospina* females from central Texas, a small number of the mated pairs produce offspring, with about thirty days required for the larvae to appear in the culture.

If the tests are to be extended beyond central Texas, crosses between *limpiensis* and *macrospina* must be used, because *subfunnebris* is completely sterile to all strains of *macrospina* coming from east of central Texas. Crosses between all *macrospina* strains and those of *limpiensis* go in both directions and produce the normal number of progeny, although when *limpiensis* is used as the female parent the male hybrids are either sterile or semi-sterile, depending upon the strain used in the cross. Mainland has shown that this particular type of sterility is due to a genic unbalance between the X and Y chromosomes.

In each cross where the two strains selected are from adjacent areas an exchange of genes occurs. Hence, it would be possible to carry this exchange in steps across the country in either direction, and this would bring about an exchange of genes between the otherwise completely isolated species of *D. subfunnebris* and *D. macrospina*.

THE MELANICA GROUP

The melanica species group has three known species: (1) *Drosophila melanica*, which occurs principally in the northern states and from which area we have strains from Wisconsin, Ohio, Maryland, Connecticut and Massachusetts; (2) *D. submelanica*, which ranges across southern United States and extends northward into the Ozarks; and (3) *D. nigromelanica*, which is found in both the North and South along with the other two forms. Extensive breeding tests have been carried out on this group by Dr. A. B. Griffen.

Males from the Wisconsin strain of *melanica* are only slightly cross-fertile to *submelanica* females. The reciprocal cross was found to be completely sterile, with but one exception, and that was the cross between Wisconsin females to Ozark *submelanica* males, which goes but slightly. Madison males of *melanica* go slightly with *nigromelanica* females from Texas. Otherwise, among northern forms, the only *melanica* strain which is cross-fertile to *nigromelanica* was one from Maryland of which the females are poorly cross-fertile to the males of the Wooster strain from Ohio. All *submelanica* strains are completely cross-sterile to all *nigromelanica* strains, irrespective of their geographical origin. The metaphase chromosomes of all three species are alike, but the salivary-

gland chromosomes of the hybrid larvae show several conspicuous inversions.

The degree of fertility in the initial crosses is always small and usually amounts to less than one per cent. These three species are almost completely isolated, but in contrast to the *macrospina* group, the isolation is between the parent forms and is not due to hybrid sterility, because all hybrids are fertile.

THE MULLERI GROUP

The first species group which we found in Texas was that of *mulleri*. It is especially interesting in that it exhibits at least six different types of isolating mechanisms. In addition to sexual, geographical and ecological isolations, and hybrid sterility, it shows two different types of zygotic mortality. There are probably as many as seven species which belong to this group. Crow has tested five of these species. These are, *Drosophila mulleri* Sturtevant, found mainly in Texas; *D. aldrichi*, which occupies much the same distribution area in Texas as *mulleri*; *D. mojavensis* from the deserts of California; *D. arizonensis* from Arizona; and *D. buzzatii*, of which single stocks are available from Argentina and Sicily.

Crosses between the several members of the group produce an unusual series of interspecific hybrids, of which only three are fertile. The main results were as follows: *Mulleri* females are cross-fertile with males of the other four species, but the reciprocal crosses are all sterile. The number of hybrids produced in each cross was small and the only fertile hybrids were the F₁ females from the cross with *mojavensis* males. The mating with *buzzatii* males gives highly abnormal flies which almost invariably die in the pupal stage. *Aldrichi* females are cross-fertile with either *mojavensis* or *arizonensis* males, producing sterile females in each case. The cross between *mojavensis* and *arizonensis* goes in both directions, producing fertile male and female hybrids when *mojavensis* is used as the female parent, and sterile male and fertile female hybrids in the reciprocal mating. *Arizonensis* females are also cross-fertile with *buzzatii* males, but the resulting hybrid larvae never develop as far as the pupal stage.

From these facts it is clear that *buzzatii* is almost completely separated from the other four species, with *aldrichi* next in order. *Mojavensis* and *arizonensis* are the most closely related species, and some workers might be inclined to regard these as subspecies.

The second type of mechanism which causes the death of the hybrid zygote was discovered by Crow while making crosses between *mulleri* and certain strains of *aldrichi*. These two species both have dense

populations and occupy a common distribution area in Texas. They are completely isolated from each other by sexual isolation and hybrid sterility, and have a certain amount of ecological isolation. *Aldrichi* is almost entirely dependent on the common prickly pear as a source of food and as a medium for the developing larvae, while *mulleri* can and does feed and breed on various other kinds of fruit.

When *mulleri* females are crossed to males of a certain strain of *aldrichi* the hybrid offspring are predominantly male. This modification of the sex-ratio is due to the lethal effect on the female zygote of a sex-linked gene (or genes) on the X chromosome of *aldrichi*. This factor has no noticeable effect within the species, but acts as a dominant semi-lethal in the interspecific cross. The net effect is the elimination of about one half of the hybrid zygotes. In species already genetically isolated from each other, it could have little advantage to the parent populations other than that of removing the competition from the hybrids.

THE VIRILIS GROUP

In many ways the virilis group is the most interesting which we have studied, and perhaps the most significant. It includes five known species. The first of these is the original form described by Sturtevant in 1916 under the name *Drosophila virilis*. The second is *D. americana* found by Spencer in 1936 in Ohio. The other three, all new to science, have been discovered by us in the last four seasons. These are *D. texana*, first taken in Texas, *D. novamexicana* from southern New Mexico and *D. montana* from the Rocky Mountain system of Colorado, Wyoming, Utah and New Mexico.

These five species show both geographic and genetic isolation to a rather high degree. On the basis of our collection records, *novamexicana* and *montana* appear to be completely isolated geographically from the other three species, and while the distribution ranges of *texana* and *americana* overlap to a certain extent, yet in the main the two species occupy different regions, *texana* being confined to the southern states and *americana* occupying an area centering in Ohio. The main distribution area of *virilis* coincides very closely with that of *texana*, but by virtue of a difference in habitats, the two species have effective ecological isolation. *Virilis* lives and breeds in stores and produce houses in a domestic-type of habitat, while *texana* lives and breeds in the woods in a wild-type habitat.

The question of genetic isolation between the several species has been discussed elsewhere at these meetings and need not be considered further here. I wish, however, to refer briefly to their chromosomes.

All five species differ from one another, either in chromosome number or in the inversions present, or in both. These differences are such that one can trace the evolution of chromosome morphology in the population, and by this means we have been able to show that *americana* evolved from hybrids between *novamexicana* and *texana*. The character of the inversions in the different strains indicates that *americana* is not a homogeneous species, for its population still contains several of the possible combinations of chromosomes of the two parent species. This chance work out the direction of evolution in the origin of this species is striking proof of the efficacy of the salivary-gland chromosome technique. As all the chromosomes differ in gene order from one another in the parent species, recombinations would occur in the descendants of their hybrids. Different strains of *americana* show a limited number of these combinations. The original strain from Smithville, Ohio, for example, has chromosomes 2, 3, 5 and Y of *texana* and X and 4 of *novamexicana*, while another stock from Ohio, known as Pee Wee, differs in having the *texana* type of the male sex-limited fourth chromosome. Still other combinations have been found in different strains.

While it is difficult to determine just where the original hybridization took place, yet there is some evidence to indicate that it occurred here in the Southwest. *Novamexicana* has been found in southern New Mexico and the distribution of *texana* extends from central Texas to the Atlantic seaboard. It is probable that at one time the distribution areas of the two populations overlapped at some point in the intervening region, which would have given the opportunity for the hybridization to occur. Wherever the exact place was, it is clear that once the new species was produced it expanded northeast into a new ecological area in and about the state of Ohio, leaving behind over the trail of its progress some of the combinations which are still to be found associated with *texana*.

DISCUSSION AND CONCLUSION

Most of the investigations of the different workers on these species groups have been concerned with the extent of, and the reasons for, their isolation. As shown above, and especially in my symposium address, various types of isolating mechanisms are present either singly or in combinations among the different groups. Their net effect is the partial or complete elimination of the exchange of genes between populations. Except for simple geographic isolation, these limiting mechanisms are due to gene mutations. Other mutations are responsible for the great variety of morphological and physiological characteristics and in relation to the isolating mechanisms and the

restrictions on gene recombinations imposed by chromosomal rearrangements, form the basis for diversification both within and between species.

It might be well to compare some of these diverse characteristics as they appear in the different members of the species groups. In the *mulleri* group, two of the species live together in the same region and are much alike as to size and color pattern, but differ from each other in the color and size of eyes, in food habits and in length of life cycles, and are completely incapable of exchanging genes. In contrast to this, two other members of the group are separated geographically and differ widely in phenotype, but are readily capable of exchanging genes when brought together.

In the *virilis* group two distinct types are found, one of which lives in a domestic-type of habitat, the other in a wild-type habitat. The two types are therefore ecologically isolated and otherwise differ from each other in a number of morphological and physiological characters. The different strains of *virilis*, which represent the domestic-type, etherize very slowly, have clear crossveins, pupate on the sides of the container, have pupae which run the entire gamut of color variation from light-tan to deep black, and are fully cross fertile. The four wild-type species all etherize very quickly, have clouded crossveins, pupate in or at the edge of the food, have pupal color which is basically red, and are not fully cross fertile. Even within the wild-type group there are many character differences. Two of these species live in a region of severe winters in the high elevations of the Rocky

Mountains and are readily distinguishable from the other two which live in a warmer climate in low wooded areas.

Some species groups are noteworthy for certain types of variation. For example, in the *pseudoobscura-affinis* complex of species extreme modifications of chromosome structure are common between related forms, but with little difference in phenotype. In the *mulleri* group modifications of phenotype are common, but differences in the chromosomes are absent between two of the genetically isolated species. The *virilis* group is remarkable among animal forms for having a clear case of hybrid origin of one of the species. The distinctness of the species in this group is in sharp contrast to the conditions found in the *macrospina* group. In the latter a series of genetic changes have accumulated so slowly across the distribution range that only the extreme ends may be regarded as distinct species.

The first of the fundamental problems propounded by Darwin was the question of the fact of evolution. This has been definitely established by a great variety of evidence from many fields of biology and geology. The second question as to how evolution actually operates is only now being elucidated, and toward the solution of this problem the contributions from the several investigations on the *Drosophila* species groups are playing an increasing role. It is no longer necessary to explain evolution by analogy, for the application of genetical and cytological techniques in this genus proves that it depends on experimentally measurable gene mutations.

STUDIES OF INFANT CHIMPANZEES

By HENRY W. NISSEN

YALE LABORATORIES OF PRIMATE BIOLOGY

ANNOUNCEMENT was made¹ in April, 1940, of an experimental chimpanzee nursery established at the Yale Laboratories of Primate Biology in Orange Park, Florida. The present report describes in greater detail the aims and methods of this program, and includes a brief account of progress to date.

Our primary general purpose in initiating this project was to provide and utilize infant chimpanzees in relatively large numbers as materials of psychological research. Heretofore very few specimens under one year of age have been available. Those few provided by dealers were invariably several months old and had limited scientific usefulness because of only approximately known age and ontogenetic history. Most of those born in captivity were, for obvious practical reasons, left with their mothers dur-

ing the first year of life or longer and were therefore unavailable for anything but casual observation. The development in these laboratories, over the past decade, of a large and healthy breeding colony, gave the first opportunity, which may not soon be repeated, to undertake a relatively extensive study of young chimpanzees during the critical period starting at birth. Generous support by the Samuel S. Fels Fund, covering the special expenses of the project over a five-year period, made it financially possible to institute the program.

By making possible control and experiment, animal research has almost invariably pioneered in widening our biological horizons. The particular advantages of chimpanzees for investigations of characteristically human phenomena are fairly obvious. The extrapolation of discoveries by analogy and the examina-

¹ SCIENCE, 91: 336-337, 1940.

tion of relatively subtle differences (as contrasted to the search for broad principles of wider applicability), both demand a high degree of similarity in research materials. Use of the anthropoids opens the possibility of observing such phenomena in relatively uncomplicated form; tracing their more immediate origins or precursors, and of analyzing what is without doubt the most significant step in mental or behavioral progression to be found within the animal continuum.

The genetic method has proven its worth repeatedly in all fields of biological inquiry; its application in the present instance seems particularly indicated. An ontogenetic study of chimpanzee should not only add meaning to the phylogenetic comparison of the ultimate (adult) characteristics of man and the anthropoid apes, but should open up an entirely new dimension of comparison, that of the dynamics of developmental trends in the two species. It seems not unreasonable to expect that in the finer analysis of these diverging trends will be found essential clues to the critical differences which define the human and subhuman primate.

Two additional but definitely subordinate goals of the project may be mentioned: (1) The captured chimpanzee, purchased from a dealer, usually brings with him a host of intestinal parasites. Some of these parasites can be exterminated without much difficulty; others it is impossible or impracticable to eradicate, especially in larger specimens. Although it is conceivable that the wild chimpanzee does not suffer—perhaps even benefits—from the parasites, it is clear that in captive animals they constitute a hazard and probably affect, to an unknown degree, various life-functions. By removing infants from the adults at birth, infestation is prevented; with the institution of various precautions against subsequent contamination, it is hoped thus to build up gradually a parasite-free colony. (2) By eliminating the period of nursing, which in chimpanzees often persists for as long as two years, a speeding-up of the breeding rate is anticipated; instead of bearing one infant every two or three years, it may be that each breeding female can produce offspring at intervals half that long. This, together with better development and lower mortality of the laboratory-raised infants (as suggested by the record thus far), should increase significantly the number of laboratory-born chimpanzees available for research here and in other institutions.

Since it has been felt that the anthropoid apes could be employed most fruitfully in the investigation of phenomena which are distinctive of the highest primates, and since man is characterized most obviously and significantly by his behavior, the central focus of this program was clearly indicated. Our interest,

accordingly, has been and is chiefly in experimental behavior analysis and in the correlation of behavior with underlying morphological and physiological factors. Our view-point, furthermore, dictates emphasis on the so-called higher mental functions (especially those seemingly mediated by symbolic processes), the secondary or derived forms of motivation and the more complicated expressions of emotion as seen especially in social behavior, rather than on relatively simple reactions which are perhaps essentially similar over a broad range of animal life.

It is clearly indicated, however, that approach to these most significant problems must be over the groundwork of preliminary information regarding basic growth phenomena in the species. After developing practicable and reasonably efficient routines for the care and feeding of infant chimpanzees, our first task, therefore, was to gather as large a body of facts as possible on the development of our subjects under these uniform conditions. No claim is made that these conditions have been "normal" or "natural"; doubtless they have fallen short of being optimal even for our purposes. In so far as considerations of health permitted, however, they have been essentially constant for all individuals. They were designed to promote healthy growth at not too great a cost in time and energy. During the first two years of life the animals are kept in individual cribs and cages. The problem of cleanliness has been solved by use of disposable diapers. Feedings are on a regular schedule decreasing in number from six at birth to four per day at age of thirteen weeks. The bottle formula is increased in strength, and new items of diet are added, at stated intervals. Except for special occasions, human contacts have been limited to four individuals: a female colored nurse, a white male assistant, Dr. Austin H. Riesen and the writer.

The schedule of tests, measurements and other records which have been made routinely, and with few exceptions² at the intervals indicated, of all members of the group, may be outlined as follows:

1. Body weight (daily at 10 A.M.).
2. Eruption of teeth (checked daily).
3. Fifty anthropometric measurements (monthly during first year of life, quarterly thereafter).
4. Physical description record of coat and skin characteristics (semi-annually during the first year, annually thereafter).
5. Photographic portraits in a standardized situation (monthly during the first year, bimonthly thereafter).
6. Radiographs (some parts monthly, others bimonthly, quarterly, semi-annually).
7. Food intake (each feeding).
8. Axillary temperature (three times weekly).
9. Pulse rate (three times weekly).

² The x-ray studies were not begun until fall, 1940.

10. Respiration rate (three times weekly).
11. Galvanic skin resistance (irregularly, under various conditions).
12. Activity records (usually continuous for 2 days or longer, at different ages).
13. Behavior tests—Gesell schedule with certain omissions and additions adapted to typically chimpanzee behavior (biweekly to the eighth week, every four weeks during the remainder of the first year, quarterly thereafter).
14. Records of behavior appearing in the nursery environment: locomotion of all kinds, vocalization, feeding habits, grooming activity, ticklishness, emotional expression, response to human contacts, ties and so on.

These "normative" data doubtless will have certain intrinsic interest and may be of value to various special branches of biological science. Our use of the results will be fourfold: (1) The data will provide base lines from which the effects of experimentally introduced variables can be measured. (2) They will be examined for intercorrelations of such "naturally" produced variations as weight and food-intake, health and bone "scars," behavioral and somatic development, parent and offspring characteristics, and so on. (3) The developmental trends manifested by the data will be compared to those of other species, particularly those of the human infant, and to the known characteristics of the adult chimpanzee. (4) Most impor-

tantly, perhaps, these results will raise questions for experimental investigation and will indicate the feasibility and significance of various lines of attack.

Since the program was initiated in July, 1939, there have been fourteen births at the laboratories, seven males and seven females. The infants were separated from their mothers soon (median, 17 hours) after parturition and were at once placed under the care of human attendants in the nursery. One male was returned to his mother 48 hours later, after the first series of tests, measurements and descriptions had been made; this animal will be the first of several "controls" who will serve to indicate the effects of our nursery environment as compared to the care given by the captive chimpanzee mother. One female was transferred to another laboratory at the age of two months. Another female died at the age of seven months; it seems highly probable that some innate weakness was primarily responsible for her death. The remaining eleven animals, the oldest ones now over two years old, are thriving in the nursery situation. The program is to include the first three years of life. The present members of the nursery will serve primarily as the "normative group," and with them the standard list of tests and measurements will be continued until they reach that age. Infants born hereafter are to be used experimentally, in accordance with the view-point and orientation presented above.

OBITUARY

HEBER D. CURTIS

THE scientific career of Heber D. Curtis began at a time when the old-line astronomy of position was being supplemented by the "new astronomy." His first important papers dealt with latitude work, eros observations, comet orbits; many of the papers after his ninth deal with astronomical spectroscopy. Dr. Curtis brought a broad and thorough training in fundamental astronomy to bear on the problems of the newer field, and the "new astronomy" has benefited greatly, directly and indirectly, through his work and his counsel. His observations of stellar spectra extend over a decade and were accompanied by measurement and discussion, the system of Castor being one of the many interesting papers which he published in these years.

His work on comets was continued for several years, and the remarkable series of photographs of Halley's Comet secured by Curtis has yielded important results in the hands of himself and others.

The work which he himself rated most highly, and which has perhaps been of greatest usefulness, is the observation of nebulae. Curtis finished the survey

begun by Keeler and discussed the results of the program in the Lick Observatory Publications. His general treatise on nebulae was published in the *Handbuch der Astrophysik*. This is an important document for any one who is interested in nebulae from any point of view.

From the beginning to near the end of his scientific activity, Curtis observed solar eclipses, taking part in the observation of eleven. In this work his mechanical genius and resourcefulness had room for full play. The discovery of the strong coronal lines in the infra-red is one of the important results of these many eclipses which has been ascribed to Curtis. Also any success which his party may have had was certainly due in part to his presence. The travel, visiting new places and meeting people of every race and culture were features of eclipse expeditions which he enjoyed and exploited to the full.

Heber D. Curtis was born on June 27, 1872, at Muskegon, Mich. At the University of Michigan he was granted the degrees of A.B. and A.M. in the years 1892 and 1893. The University of Virginia granted him the Ph.D. degree in 1902; and from the

University of Pittsburgh he received the honorary degree Sc.D. in 1930. He was a member of the Astronomical Society of the Pacific (President, 1912); American Association for the Advancement of Science (vice-president, Section D, Astronomy, 1924); American Astronomical Society (vice-president, 1926); Astronomische Gesellschaft; National Academy of Sciences; American Philosophical Society; Research Club (University of Michigan); foreign associate, Royal Astronomical Society; International Union; member of Commission 13 of solar eclipses; Phi Beta Kappa; Sigma Xi; Phi Kappa Phi.

He taught Greek and Latin at Napa College from 1894 to 1896, and was professor of mathematics and astronomy at the College of the Pacific from 1896 to 1900. As a teacher and public lecturer he was unexcelled. He had the faculty of presenting astronomy to the beginner or to the layman in such a way as to display the facts and instill the spirit of the science. After two years as Vanderbilt fellow at the University of Virginia he joined the staff of the Lick Observatory in 1902, rising to the rank of astronomer in 1911, a position which he left to become director of the Allegheny Observatory in 1920. His stay at Lick was interrupted in 1906 when he went to Santiago, Chile, in charge of the Lick Southern Observatory, from which station he returned in 1910 to take charge of the Crossley Reflector. His engineering ability was used here in providing convenient controls and working conditions for this erstwhile troublesome instrument. In 1917 he joined the optics section of the National Bureau of Standards, and worked at the design of military instruments, returning to Lick when hostilities ceased.

Beginning in 1920, Curtis spent a happy decade at the Allegheny Observatory. Here, besides doing his share of observing, he designed and constructed several instruments whose use has simplified and improved observation. He took great enjoyment in this work, at which he was unusually skilful. In fact, the planning and building of new instruments for eclipse work was perhaps the most enjoyable feature of the five expeditions which he accompanied or led in the Allegheny decade. Wherever he was located, Curtis always found opportunity to improve the equipment, often by his own handiwork.

In 1930 Michigan sought a man to design a new telescope and called Curtis to the directorate of the University Observatory. The proposed large reflector did not materialize, but a development of far greater promise grew under his guidance in this last decade. And this was possible because Curtis not only knew science and mechanics, but understood men and was able properly to estimate their potentialities and direct their abilities. The solar work of the Me-

Math-Hulbert Observatory is in a very true sense a monument to such understanding and encouragement. His friendly disposition and constant desire to be helpful not only accomplished much for science but made him beloved by all his associates.

The few philosophical papers presented by Curtis have a value which is large in comparison with the number of pages written. Curtis published about 120 papers dealing with scientific subjects and 20 of a more general nature. Many of these are of prime importance, but they imply, rather than record, his value to science, which resided rather in his helpfulness to his associates through counsel and encouragement.

The passing on January 9, 1942, of this scientific teacher and counsellor created an unusual feeling of loss and sorrow. Dr. Curtis is survived by his wife Mary D. Curtis; by a daughter, Mrs. A. J. Walters; by three sons, Rowen D., Alan B. and Baldwin R., and by five grandsons. To these the world of science expresses deep sympathy.

KEIVIN BURNS

DEATHS AND MEMORIALS

DR. SOMA WEISS, Hersey professor of the theory and practice of physics at Harvard Medical School and physician in charge of the Peter Bent Brigham Hospital, died on January 31, at the age of forty-three years.

BION J. ARNOLD, consulting engineer, died on January 29, at the age of eighty years. Mr. Arnold had been a mechanical engineer for the Chicago and Great Western Railway, a consulting engineer for the General Electric Company and an advisory traction engineer for the cities of Pittsburgh, Toronto, Chicago, Providence, Los Angeles, Cincinnati and San Francisco.

DR. FRANK SMITH, professor emeritus of zoology at the University of Illinois, died on February 3, at the age of eighty-five years.

CLIFFORD C. GLOVER, professor of pharmacognosy of the College of Pharmacy of the University of Michigan, died on January 31, at the age of fifty-four years.

DR. MARTHA BREWER LYON, member of the Association for Research in Ophthalmology, South Bend, Indiana, died on January 18, at the age of seventy years.

CAPTAIN THOMAS ATHOL JOYCE, formerly deputy keeper in charge of the Sub-Department of Ethnography, department of oriental antiquities and ethnography, in the British Museum, and president of the Anthropological Institute from 1931 to 1933, died on January 3, at the age of sixty-four years.

THE Gray Herbarium of Harvard University is completing, through a special gift, an addition to its building to be called the Benjamin L. Robinson Wing in memory of Professor Robinson, formerly curator of the herbarium. The plans for the equipment of this wing contemplate an additional expenditure of \$35,000. Professor Robinson died on July 27, 1935.

As a memorial to Professor E. P. Kohler, professor of chemistry at Bryn Mawr College until 1912 and, at the time of his death in May, 1938, Sheldon Emery professor of organic chemistry at Harvard University, a fellowship for graduate study in chemistry has been endowed through contributions of his students and friends. The announcement says: "The special purpose of the fellowship is to perpetuate the

memory of a man distinguished by his eminence as a scientific man and beloved as a teacher of rare qualities who exerted a profound and wide-spread influence on the progress of instruction in chemistry throughout the country."

A MEMORIAL service for Professor Frances Gertrude Wick, chairman of the department of physics and a member for thirty years of the faculty of Vassar College, was held in the college chapel on January 21. Professor Louise S. McDowell, chairman of the department of physics at Wellesley College, gave the principal address. Dr. Henry Noble MacCracken, president of the college, spoke on behalf of the faculty, and Louise Grosvenor, of New York, a junior majoring in physics, on behalf of the students.

SCIENTIFIC EVENTS

THE FIFTH GENERAL HOSPITAL (HARVARD UNIVERSITY UNIT), U. S. ARMY¹

AT 9:00 A.M. on January 10 the U. S. Army Fifth General Hospital (Harvard University Unit), the successor to Base Hospital No. 5 of 1917-19, left Boston for an eastern seaboard camp as the first step to active duty in this war. This represents a further contribution of Harvard University to National Defense. Harvard University has already established in England an American Red Cross-Harvard Hospital, directed by Dr. John E. Gordon, professor of preventive medicine and epidemiology, which for some months has been actively engaged in aiding the British in the care and study of communicable diseases.

The former Base Hospital No. 5 was presided over by the late Dr. Harvey Cushing and had an enviable record. Many of its officers rose to positions of importance in the Army. The hospital suffered the first American casualties, when it was bombed the night of September 5, 1917.

Now after a twenty-year interval a new group undertakes a similar effort. For historical purposes the following should be recorded. On November 16, 1939, the Surgeon General of the United States Army wrote Dean Burwell of the Medical School that shortly he would approach the Medical School with an official request that it organize a regular Army inactive unit, General Hospital No. 5, "thus perpetuating the fine traditions of United States Army Base Hospital No. 5." Similar units were proposed for all medical schools and hospitals which had served in a like capacity in the War of 1914-1918. These units were to have a normal bed capacity of 1,000 and a personnel which would include 42 officers, 120 nurses and 400

enlisted men. Subsequently the number of officers was raised to 73, including the administrative service.

The office of Unit Director was assigned to the author, and immediately steps were taken to secure the officer personnel, which according to instructions should be limited to members of the parent institution. Members of the teaching force of the Medical School, whether working in the laboratories of the school or attached to one of the affiliated hospitals, were eligible. The heads of all departments in the school were consulted as to what men in their department either cared to join or, in the opinion of the head of the department, should not join because of essential duties here. A definite attempt was made to spread the personnel as widely as possible. Because of the ramifications of the university, we were able to call upon individuals from all the major Boston hospitals as well as from the Hygiene Department in Cambridge. Thomas H. Lanman, '12, M.D., '16, assistant professor of surgery, and Theodore L. Badger, M.D., '26, instructor in medicine, were early selected as the respective chiefs of the Surgical and Medical Divisions. Their continued labors and unflagging interest have greatly facilitated the formation of the present unit.

On December 24, 1941, a telephone call from the Surgeon General's office warned the unit that it would have only a few days to prepare for active duty. Immediately final physical examinations, the purchase of equipment and the addition of the nurses and the new officers were undertaken. The necessary prophylactic inoculations were started. Boston stores were called on to supply uniforms, the style, quality and types of these being added to each day. A hurried trip to Washington by the acting director expedited these matters.

Generous friends donated money for a Fifth Gen-

¹ Reprinted by special permission of the *Harvard Medical Alumni Bulletin*, January, 1942, issue.

eral Hospital Fund, similar to that possessed by the hospital in the last war. With these funds assistance has already been given in many ways to officers and to the nurses. The Boston Metropolitan Chapter of the American Red Cross donated sleeping bags to all nurses going with the unit.

At 5:00 P.M. on January 9, members of the former Base Hospital No. 5 who had formed themselves into Harvard Base "5" Club presented colors to their successor unit, the new Fifth General Hospital, which has now gone on active duty. The colors were presented by Dr. Lewis M. Hurxthal, of the former unit, to Lt. Col. Theodore L. Badger, chief of the Medical Service of the new unit. The ceremony was attended by the following members of Base Hospital No. 5 of 1917-1919 and many friends: Walter J. Irving, William F. Whitley, Montgomery C. Reed, Kenneth J. Crowell, Joseph J. Wilson, Dr. Lewis M. Hurxthal, Harold J. Davidson and Dr. Elliott C. Cutler.

Dr. Hurxthal's speech of presentation follows: "Twenty-five years ago, United States Army Base Hospital No. 5 of World War I was organized. The unit embarked in May, 1917, and took over active hospital work in June, 1917, in France. Under the direction of Colonel Robert U. Patterson and Colonel Harvey Cushing, Base Hospital No. 5 performed an outstanding service to the wounded and sick in France and contributed much to military medicine. Two of the outstanding contributions were in the field of brain surgery and in the introduction of blood-grouping to the British Army. Many lives were saved because of these contributions.

"The members of former Base Hospital No. 5, officers, nurses, and enlisted men, are proud of their war record of two years service in France. They are also proud that a new unit will carry on under the same name, and are confident that it will return with the same enviable record as its predecessor.

"Harvard Base '5' Club is an organization founded in 1929 by former members of the United States Base Hospital No. 5. In behalf of all the members of the unit, Harvard Base '5' Club wishes to contribute a connecting link between the old and the new. The two groups have many things in common: both were organized in Boston; both were composed of volunteers; and both were called to duty within a few weeks after the declaration of war. We have, therefore, chosen as a bond of continuity the American Flag. We hope this particular flag will serve as the official colors of the new organization as well as an inspiration for a meritorious performance of duty. We wish you success and bon voyage."

* * * * *

The orders for the unit activated forty-seven officers, leaving eleven behind whose papers had not yet been completed to wait for subsequent orders to join the

unit. These orders came shortly, and one week later, on January 17, the second group left Boston to join the main body of the unit.

Forty-four nurses left with the unit representing the following hospitals: Arlington Training School, Beth Israel Hospital, Children's Hospital, Homeopathic Hospital of Rhode Island, Massachusetts General Hospital, McLean Hospital, New England Baptist Hospital, New England Deaconess Hospital, Peter Bent Brigham Hospital, Robert Breck Brigham Hospital and Sturdy Memorial Hospital.

At the last minute the acting director was refused permission by the Surgeon General to leave with the unit because of the urgent request of the university that his duties were essential for the moment here.

We who remain behind must look with pride and gratitude on these men and women who have now accepted the call to serve their country. We know of their great abilities and feel sure that they will fulfill adequately the high traditions of their predecessors and will play a major role in the United States Army Medical Corps from now until they return to us. To their families we extend our congratulations and our devotion. The university will long cherish this effort on the part of its graduates.

ELLIOTT C. CUTLER, M.D.

THE NEW NATIONAL ASTROPHYSICAL OBSERVATORY OF MEXICO

MANY astronomers, physicists and geologists, from both North and South America, will participate in the Inter-American Scientific Conference in Mexico, which meets from February 15 to 26, on the occasion of the dedication of the new National Astrophysical Observatory.

President Manuel Avila Camacho, of Mexico, in his invitation said: "The purpose of the Mexican Government is to contribute to the maintenance, in the American continent, of the progress of science and culture, and thus counteract as much as possible the paralyzation of scientific and cultural activities in the countries devastated by war."

On the provisional program for the conference are the names of many of the leading astronomers of the United States, including Dr. Walter S. Adams, director of Mt. Wilson Observatory; Dr. Henry Norris Russell, director of Princeton Observatory; Dr. Harlow Shapley, director of the Harvard College Observatory; Dr. V. M. Slipher, director of the Lowell Observatory; Dr. Joel Stebbins, president of the American Astronomical Society, and Dr. Otto Struve, director of the Yerkes and McDonald Observatories.

Argentina will be represented at the conference by the director of the National Observatory at Cordoba, Dr. Enrique Gaviola, who will preside at one of the

sessions, while from Canada will come Dr. Joseph A. Pearce, director of the Dominion Astrophysical Observatory, Victoria, British Columbia. Leading Mexicans participating in the conference are: Professor Luis Enrique Erro, director, and Dr. Carlos Graef, assistant director, of the new National Observatory; Dr. Monges-Lopez, dean of the faculty of sciences of the National University of Mexico; Professor Manuel S. Vallarta, of the Massachusetts Institute of Technology; Dr. Joaquín Gallo, director of the National Observatory at Tacubaya, and Dr. Alfredo Banos, Jr., head of the department of physics of the National University.

Nearly the entire field of modern astronomy and geophysics will be covered by the papers to be presented at the various conference sessions, the subjects of which are: The interstellar medium, the classification of stellar spectra, problems of the galaxy, variable stars, time and change, cosmic radiation and geophysical problems. In addition, there will be special evening lectures on related topics, as follows:

The Surfaces of the Major Planets: Dr. Slipher.

The Cosmogonical Significance of Stellar Rotation: Dr. Struve.

The Present State of the Theory of Stellar Evolution: Dr. Russell.

Time and Change in the Metagalaxy: Dr. Shapley.

Most of the sessions and lectures will be held at Puebla, including the dedicatory exercises on the morning of February 17. Dedicatory addresses will be given by President Camacho and the Governor of Puebla. For special academic ceremonies an excursion will be made to Morelia on February 23 and 24, with the final sessions being held in Mexico City.

The new National Astrophysical Observatory is situated on land provided by the government of the State of Puebla, near a small town of Aztec origin called Tonanzintla, about eighty miles east of Mexico City. Under the direction of Sr. Erro, observations of the southern Milky Way will be made with a 24-30-inch Schmidt camera, the most powerful telescope in the tropics. This instrument is similar to the Jewett telescope at Harvard Observatory, and was mounted in the Harvard shops. Its location in latitude 19° is strategic for studies of the southern parts of the sky, inaccessible to instruments farther north. The climate is excellent for observations, especially during the winter, and the program of the observatory also calls for variable-star studies and observations of meteors and the sun.

THE SUMMER SESSION OF NEW YORK MEDICAL SCHOOLS

IN response to the present need for the training of a large number of men in medicine to take the places

of those called into service, an accelerated program for the course has been announced by the five medical colleges in New York City.

At the Columbia College of Physicians and Surgeons, the Cornell University Medical College, the Long Island College of Medicine, the New York Medical College and the New York University College of Medicine, plans have been formulated to conduct regular work for all classes during the coming summer and to open the next regular session early in July. The new schedules adopted in these institutions will make it possible for the student to cover the full medical course within the space of thirty-six months instead of, as at present, distributed over forty-eight months.

Under the accelerated plan as announced, however, there is to be no reduction in the amount of time the student devotes to his medical training and, likewise, there will be no relaxation in the standards of teaching in the medical course. Instead of the summer vacation of approximately three months, the students under the new plan carry on regular work in the classrooms, laboratories and hospital wards, thereby shortening the time of the medical course by one year. Although the course is practically continuous, throughout the year, short vacations will be given between each of the four terms.

The five New York City medical colleges would normally graduate under the present plan approximately 1,350 physicians in a three-year period. Under the accelerated schedule it would be possible, if continued, for these schools to graduate 1,800 in the same period, or approximately 450 additional doctors to enter internships in the hospitals. Since the Army and Navy are calling many young physicians from the hospital staffs, this increase in the number of medical graduates may mean much in the care of the sick and in supplying the needs of the military services.

AWARDS FOR ACHIEVEMENT IN AERONAUTICS

THE tenth annual meeting of the Institute of Aeronautical Sciences was held in New York City during the week of January 26. *The New York Times* reports that the annual dinner presentation was made of six awards for achievements in aeronautics.

Juan Terry Trippe, president of Pan American Airways, received the Daniel Guggenheim Medal, awarded annually since 1926, for his achievement in the development and operation of oceanic air transport. The presentation was made by Brigadier General Donald H. Connolly, national director of civil aviation of the Army Air Force.

The Sylvanus Albert Reed Award went to Theodor von Kármán, director since 1930 of the Daniel Guggenheim Graduate School of Aeronautics at the California Institute of Technology, for "the development of a satisfac-

tory theory of the influence of curvature on the buckling characteristics of aircraft structures." The presentation was made by Dr. J. C. Hunsaker, chairman of the National Advisory Committee for Aeronautics.

Melvin Nielson Gough, senior test pilot at the Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics, was given the Octave Chanute Award for "outstanding contributions to fundamental research in aeronautics as conducted in airplanes in actual flight." He received the award from Lieutenant Colonel James H. Doolittle, director of operational requirements, headquarters staff, Army Air Force.

The Lawrence Sperry Award, as already reported in SCIENCE, went to Ernest Gordon Stout, engineer in charge of air dynamics for the Consolidated Aircraft Corporation, for his contributions "to the experimental determination of hydrodynamic stability of model flying boats and sea planes." The presentation was made by Charles H. Colvin, of the Daniel Guggenheim Graduate School of Aeronautics.

Major Harry George Armstrong, of the U. S. Army Medical Corps, received the John Jeffries Award for "basic studies on the physiological and psychological effects of flight at high altitudes and the description of a number of clinical entities involved, the establishment of the Army Aero Medical Research Laboratory and contributions to the literature of aviation and medicine." The presentation was made by Dr. Louis H. Bauer, editor of *The Journal of Aviation Medicine*.

The Robert M. Losey Award was presented to Dr. Horace Robert Byers, meteorologist of the United States Weather Bureau, for "research in air mass analysis and its application in synoptic and aeronautical meteorology." The presentation was made by Dr. F. W. Reichelderfer, chief of the United States Weather Bureau.

Frank W. Caldwell, director of research at the United Aircraft Corporation and president of the institute, presided over the ceremonies.

ADVISORY COMMITTEE ON SCIENTIFIC PUBLICATIONS

MANY investigators who are planning to submit manuscripts or abstracts for publication will undoubtedly have occasion during the war emergency to query whether the publication might not inadvertently become of assistance to our enemies. Since it may be impossible for the author to answer the question from his own personal knowledge, the National Academy of Sciences and the National Research Council have organized an Advisory Committee on Scientific Publications to deal with the matter. This committee is ready to advise editors of journals and secretaries of societies concerning the procedure to follow when manuscripts or abstracts that might fall into this category are submitted for publication or question is raised concerning an investigation in progress. If it is decided that postponement of publication is advisable, the author and editor are so informed. When postponement of publication is no longer necessary, and the manuscript or abstract is published, there will be an accompanying note indicating the date on which the paper was received for publication and that the paper was withheld because of its bearing on the war emergency. Although this will mean delay in publication for a time in some cases, in others it will facilitate the publication of results which otherwise might be withheld owing to the author's uncertainty as to the possible military significance of his work.

FRANK B. JEWETT,

President, National Academy of Sciences

ROSS G. HARRISON,

Chairman, National Research Council

LUTHER P. EISENHART,

Chairman, Advisory Committee on Scientific Publications

SCIENTIFIC NOTES AND NEWS

THE Society of Economic Geologists, on the recommendation of a committee consisting of B. S. Butler, T. S. Lovering and Adolph Knopf, chairman, has awarded its Penrose Medal to Professor William H. Emmons, of the University of Minnesota, in recognition of his outstanding contributions to the science of economic geology. The presentation was made on February 10, at the annual dinner of the society in New York.

JOSEPH J. GEORGE, chief meteorologist of the Eastern Air Lines, has been presented with the Meisinger Award of the American Meteorological Society for the "most outstanding work in the aerological field during the year." The award was based upon Mr. George's work in fog prediction and the effect of lakes on air distortion. Presentation of the award was made at

the recent annual business meeting of the society held at Columbia University.

PROFESSOR JOHANNA WESTERDIJK, director of the Phytopathological Institute and the Central Bureau for Fungus Cultures in Baarn, the Netherlands, celebrated the twenty-fifth anniversary of her appointment to the first professorship in plant pathology at a Netherlands university on February 10. A congratulatory telegram has been sent to her by her American colleagues, from South America. The collections of the Central Bureau and of her laboratory have not been damaged in any way by the war, and all work is being continued by the complete staff, as in former years.

THE University of San Marcos, Peru, has awarded the degree of doctor *honoris causa* to Dr. William

Seaman Bainbridge, of New York City, in recognition of his work on cancer and his contributions to medical progress in Latin America.

DR. FRANK S. HOGG, assistant professor of astronomy at the University of Toronto and a member of the staff of the David Dunlap Observatory at Richmond Hill, Ont., was re-elected president of the Royal Astronomical Society of Canada at the recent annual meeting. Other officers elected were: *Vice-presidents*, Dr. A. Vibert Douglas, dean of women, Queen's University, and Dr. A. E. Johns, of McMaster University; *General Secretary*, E. J. A. Kennedy; *General Treasurer*, J. H. Horning; *Recorder*, H. W. Barker; *Librarian*, Dr. P. M. Millman; *Curator*, R. S. Duncan, all of Toronto.

At the annual business meeting of the Ecological Society of America, held in Dallas, Texas, on December 31, the following officers were elected: *President*, 1942, C. F. Korstian (botany), Duke University; *Vice-president*, 1942, C. E. ZoBell (zoology), Scripps Institution; *Secretary*, 1942-44, William A. Dreyer (zoology), University of Cincinnati; *Representative on the National Research Council*, 1942, Ira N. Gabrielson (conservation), U. S. Biological Survey; *Representative on the Council of the Union of American Biological Societies*, 1942, A. M. Banta (biology), Brown University. Dr. Royal E. Shanks (botany), State Teachers College, Clarksville, Tenn., continues in office as treasurer of the society. The work of two of the committees essential to the program of the society was approved and it was voted to continue their activities. They are: Committee on the Preservation of Natural Conditions, *chairman*, Curtis L. Newcombe (biology), College of William and Mary; Committee for the Study of Plant and Animal Communities, *chairman*, S. Charles Kendeigh (zoology), University of Illinois.

DR. J. A. W. HETRICK, professor of otolaryngology and director of the department, and since 1924 assistant and associate dean, has been appointed dean of the New York Medical College Flower and Fifth Avenue Hospitals. He has been serving as acting dean since March, 1941, following the death of Dr. Claude A. Burrett.

DR. JOHN H. MUSSER, professor of medicine at the School of Medicine of Tulane University of Louisiana, has resigned as president of the State Board of Health, in order to devote all his time to work at the School of Medicine.

DR. JOHN W. BARNARD, assistant professor of anatomy at the Georgetown Medical School, has been appointed professor and head of the department of

anatomy at the new School of Medicine of Oglethorpe University.

ALLYN R. JENNINGS, since July, 1940, general director of the New York Zoological Park, has left to become associated with the Pan American Airways system in an engineering capacity. Mr. Jennings, before becoming director of the park, was superintendent of parks in New York City under Park Commissioner Robert Moses.

DR. MAURICE HOLLAND, formerly director of the Division of Engineering and Industrial Research of the National Research Council, has been appointed industrial research adviser to the New York University College of Engineering. Charles H. Colvin, director of the Guggenheim School of Aeronautics at the college, has been made coordinator of research, to work with Dr. Holland. Mr. Colvin founded and is a former president of the Pioneer Instrument Company. Before going to New York University he was chief of the instrument division of the U. S. Weather Bureau in Washington.

A. W. THORSEN, of Detroit, assistant fuel service engineer for the Chesapeake and Ohio Railway Company for the last two years, has been appointed a member of the staff of the Coal Research Laboratory at Carnegie Institute of Technology. He assumed his new work on February 1. Mr. Thorsen will assist the president in securing financial support for the laboratory and will also assist Dr. H. H. Lowry, director of the laboratory, with its general business operations.

A SUBCOMMITTEE on anthropology for Latin America has been appointed by the National Research Council, consisting of Dr. A. L. Kroeber, professor of anthropology, University of California; Dr. F. W. Hodge, of the Southwest Museum, Los Angeles, and Dr. Donald Brand, of the University of Mexico, to assist in carrying out the plans of the State Department for furthering research and anthropological study in Latin American countries. These plans include an exchange of cultural envoys and a study of ethnic traits.

DR. HARLOW SHAPLEY, director of the Harvard College Observatory, spoke on February 12 at the University of Texas on "Stars over Texas." Dr. Arthur H. Compton, University of Chicago, will speak on February 20. The title of his lecture will be "Physics Looks at the Future."

DR. CONRAD A. ELVEHJEM, professor of biochemistry at the University of Wisconsin, delivered on February 3 the first Mary Swartz Rose memorial lecture at the Academy of Medicine, New York City. He spoke on "Natural Foods in the American Diet."

tary." The lecture was sponsored by the Greater New York Dietetic Association in memory of Dr. Rose, professor of nutrition at Teachers College, Columbia University.

DR. MEL. T. COOK, who retired last year as plant pathologist at the Puerto Rico Agricultural Experiment Station, recently gave a series of lectures on "Virus Diseases of Plants" and on "Science in Latin America" at the Oklahoma Agricultural and Mechanical College.

DR. GEORGE W. CORNER, director of the department of embryology of the Carnegie Institution of Washington, gave at Princeton University, from February 9 to 13, a series of public lectures on the Louis Clark Vanuxem Foundation. His subject was "Ovarian Hormones in Human Reproduction."

DR. KARL K. DARROW, research physicist of the Bell Telephone Laboratories, New York City, addressed on January 22 a joint meeting of the University of Cincinnati Chapter of Sigma Xi and the Cincinnati Section, Student Branch of the American Institute of Electrical Engineers, the Institute of Radio Engineers, the Illuminating Engineering Society and the Engineers' Club of Cincinnati. He spoke on "Physical and Chemical Forces."

At the Johns Hopkins University, the twenty-third course of Herter lectures was given on February 3, 4 and 6 by Dr. Edgar Douglas Adrian, professor of physiology at the University of Cambridge. The general subject of the lectures was "The Organization of the Senses."

THE Civil Service Commission, recruiting for the Federal Civil Service, is accepting applications for all grades and branches of engineering. Some of the engineering examinations have been recently consolidated and modified. None requires a written test. For the junior grades, \$2,000 a year, applicants are rated on their engineering education; no experience is required. In the upper grades, applicants are rated on education, experience and record of accomplishments. In all but the examination for chemical engineer, professional engineering experience may be substituted for the college work. Salaries for chemical engineer are \$2,600 to \$5,600. There is a shortage of engineers experienced in specialized branches of plant layout, equipment design, market analysis, chemical economics, heavy chemicals, plastics, rubber, agricultural by-products and strategic minerals. Naval architect, marine engineer, \$2,600 to \$5,600 a year. Engineer (all other branches), \$2,600 to \$5,600 a year. For all upper grades the age limit is sixty years except that for the three highest grades of marine engineering and naval architecture—\$3,800 to \$5,600 a year—the age limit is seventy years. There are

also opportunities in the sub-professional and lower grades. Applications for all these positions are being accepted for several months or until further notice. Full information can be obtained from the U. S. Civil Service Commission, Washington, D. C., or from any first- or second-class post office.

THE National Research Fellowship Board in the Natural Sciences has extended the time for receiving applications for fellowships until February 23. Application forms and announcements stating conditions of award will be sent on request, which should be addressed to the Board at the National Research Council, 2101 Constitution Avenue, Washington, D. C.

APPLICATIONS to the Committee for Research in Problems of Sex, National Research Council, for financial aid during the fiscal year beginning July 1, in support of work on fundamental problems of sex and reproduction, should be received before April 1. They may be addressed to the chairman, Dr. Robert M. Yerkes, Yale School of Medicine, New Haven, Conn. Although hormonal investigations continue to command the interest and support of the committee, preference, in accordance with current policy, will ordinarily be given to proposals for the investigation of neurological, psychobiological and behavioral problems of sex and reproduction.

A NEW organization for botanists of the Chicago area was recently formed at the Chicago Academy of Sciences. The group has selected for its name the Cowles Botanical Society, honoring the late Dr. Henry C. Cowles, a distinguished botanist of the Chicago area. Meetings are held in the Academy of Sciences at 8:00 P.M. on the third Tuesday of each month. The objectives of the society are to promote better contacts between persons interested in botany, to collaborate in the attack on various botanical problems, and to provide renewed inspiration and stimulation in botanical studies. All interested in botany are cordially invited to attend the meetings. Dr. Max Britton, of the department of botany at Northwestern University, was the speaker at the January meeting. He spoke on "Observations on the Hemlock-White Pine-Northern Hardwood Forest of Pennsylvania." The February meeting will be held on Tuesday evening, February 17. Dr. Charles A. Shull, of the department of botany at the University of Chicago, will speak on "New Developments in Plant Physiology."

DEDICATION of the Hooker Scientific Library to American scientists was announced by the "Friends of the Hooker Scientific Library" in the January issue of their official organ, *Record of Chemical Progress*. The dedication is in fulfillment of Dr. Hooker's desire, but was not publicly announced until the library was able to establish a comprehensive plan

of technical literature services. As another step toward making these services available a revised schedule of corporation and institutional membership fees is announced. The minimum fee for permanent membership, which has been \$100 for any corporation or institution, remains at this level for laboratories having ten or more research workers. For smaller laboratories it is based on the size of the research staff. Full information about the library as a non-profit service institution may be obtained from the Hooker Scientific Library, Central College, Fayette, Mo.

THE annual California Audubon Convention was held at Santa Barbara from January 23 to 25. The exhibits included paintings by and objects connected with Audubon, and these were discussed by Donald Culross Peattie, who also spoke on the life of Audubon. There were shown many colored motion picture films and Kodachromes, such as those of Mrs. Laurel Reynolds of California birds, Mr. Hoff's life history of the brown-tailed humming-bird, Mr. Harwell's picture of the Audubon Nature Camp in Maine, Mrs. Hood on the young of the California woodpecker and F. F. Gander on Lower California.

THE Council on Dental Education of the American Dental Association has issued a series of recommendations to the dental schools of the United States with reference to an acceleration of their work for the period of war emergency. These recommendations are essentially: That such acceleration be undertaken where it is possible without loss in teaching effectiveness; that there be no reduction in the number of hours devoted to the dental course; that so far as practicable the accelerated program should begin June, 1942. The council plans to gather data from the various schools concerned regarding the additional financial burden on the school and student. This information will be used to make known to university officials and Federal agencies the financial needs of dental education.

PROVISIONAL commissions as ensigns will be granted by the Navy, on application by students, to young men taking pre-medical college work who have been accepted for the next entering classes in Class A medical schools. After completing medical courses and serving internships of one year each, they will be commissioned as lieutenants, junior grade, and called to active duty. The granting of provisional commissions will serve to prevent the drafting of such students.

DISCUSSION

INSECTS AS CARRIERS OF POLIOMYELITIS VIRUS

IN SCIENCE for December 19, 1941, A. B. Sabin and Robert Ward report the recovery of the virus of poliomyelitis from the bodies of certain flies. Their account leaves no doubt as to the presence of active virus as shown by its infectivity for *Cynomolgus* monkeys when the latter received simultaneous doses of the insect material through several portals (intraperitoneally, intranasally and by mouth). As they cite several other similar recoveries besides those recently reported by Paul *et al.*¹ it is clear that the virus of poliomyelitis may be acquired under natural conditions by certain flies and may temporarily retain its virulence on or within their bodies. Where the flies may have obtained it must remain conjectural, but it is reasonable to suppose that it may have come directly from human alimentary dejecta or secondarily from sewage, since the active virus is well known to be recoverable from these media. It has, of course, long been known that houseflies (*Musca domestica*) fed on suspensions of spinal cord may retain the virus on the body or within the alimentary tract in an active condition for a limited time.

If, as seems highly probable, poliomyelitis is spread

¹ J. R. Paul, F. D. Trask, M. B. Bishop, J. L. Melnik and A. E. Casey, SCIENCE, 94: 395, 1941.

in some way through the agency of insects, it is very important to know what species are involved in all experimental studies. Sabin and Ward refer in one case to "flies—mostly large green ones and many house flies" and at another place describe a sample used to infect a monkey as containing small houseflies, green flies, large black flies, a moth, a caterpillar and a four-winged insect. Considering the great diversity of insects and the high specificity that exists between certain insect-borne diseases and particular insect vectors, such identifications are naïvely vague for an otherwise carefully executed experiment. One may guess that the large green flies were probably a species of *Lucilia* which commonly visits feces or garbage but does not ordinarily contaminate human foods. The houseflies were probably correctly identified, as this is our commonest domiciliary species. The "small houseflies" may have been the same, or possibly the more diminutive *Fannia canicularis*, often numerous in houses, but having very different habits. The large black flies are still more indefinite. They were hardly the large blood-sucking *Tabanus atratus* and most likely refer to some species of *Cynomyia* or a related genus. The materials with which traps are baited determines to a great extent what species may be caught, and blood-sucking flies are attracted almost

exclusively only to living animals. The caterpillar was no doubt innocuous; some species are a favored delicacy not only for monkeys but for human aborigines in many parts of the world. Altogether, in these studies, it is clear that the suspected culprit (if specific) has escaped identification by mingling with a motley crowd of other insects.

There are numerous facts relating to the epidemiology of poliomyelitis that are readily compatible with the belief that insects are at least a major factor in its spread. Many of these are utterly at variance with the assumption so long current that it is spread by healthy human carriers, although they have commonly been disregarded by the proponents of this view.

During the early epidemics of poliomyelitis in Massachusetts and later at the time of the great outbreak in New York City in midsummer, 1916, the writer attempted to correlate the epidemiology of this disease with reference to some possible insect vector.^{2,3,4} There are wide differences among the several insects known to be vectors of disease, with reference to distribution, seasonal prevalence and association with the artifacts and ecological changes introduced by civilized life in varied types of human communities. On account of the immutable instinctive behavior of insects in general and our extensive knowledge relating to special groups like mosquitoes, biting flies, fleas, lice, *et al.*, it is by no means idle speculation to apply the deductive method in considering their possible relationship to the epidemiology of a disease like poliomyelitis. Experimental research in several other directions has so far developed no clear picture either of the manner in which poliomyelitis is spread during epidemics, or of how sporadic cases arise. Exact geographical, ecological and seasonal prevalence, relation to lanes of human and animal movement, barriers to insect and animal migration, breeding places, food preferences and the like are differential characteristics of particular insects and as such they are highly significant in this connection.

Preliminary studies, conducted in Massachusetts during 1911 and 1912, indicated a possibility that the biting stable-fly (*Stomoxys calcitrans*) might serve as an insect vector. Corroboratory work by Rosenau and Brues⁵ in transmitting the disease in rhesus monkeys by the bites of this fly were promptly confirmed by Anderson and Frost.⁶ However, these results could not be repeated by the same workers, nor by others who later made the attempt, and it was obvious that

² C. T. Brues and P. A. E. Sheppard, *Jour. Econ. Entom.*, 5: 305-324, 1912.

³ C. T. Brues, *Monograph on Epidemic Poliomyelitis in New York City in 1916*, pp. 136-177, 1917.

⁴ C. T. Brues, *Scientific Monthly*, 16: 471-478, 1923.

⁵ Bull. State Bd. Health, Massachusetts, Vol. 7, p. 1733, 1912.

⁶ Public Health Repts., 27: 1733, 1912.

some factor had been overlooked in the first trials; perhaps epizootic parasites like fleas may have escaped attention.

In 1916 a considerable amount of circumstantial evidence was brought to light indicating that poliomyelitis might depend upon dissemination by some insect incapable of free and rapid migration. On this basis it appeared from considerations of seasonal prevalence, distribution in human communities, lines of migration and apparent scattered endemicity, that poliomyelitis is strikingly similar to bubonic plague in its epidemiology. Thus, the pattern of epidemics in relation to population density, their spread with little reference to human travel or activities and the paucity of multiple cases in families, are all prominent features of both poliomyelitis and bubonic plague. The latter is, of course, in recent times restricted almost entirely to tropical regions. It was not recognized then that any rodent was susceptible or capable of acting as a reservoir of poliomyelitis, and desultory attempts at that time to demonstrate the virus in trapped rats were unsuccessful. At about the same time, Richardson⁷ had pointed out certain peculiarities of the epidemiology of poliomyelitis that led him to suspect some association with rats. The virus can now readily be propagated in certain rodents, following the discovery by Armstrong in 1939 that the cotton rat (*Sigmodon hispidus hispidus*) is susceptible to the experimentally implanted virus.

As it grows increasingly evident that the spread of poliomyelitis can not be traced to direct human contact nor to indirect contact through healthy human carriers, medical investigators have naturally turned their attention to other likely channels of infection, and certain flies are now under suspicion in connection with the belief that the alimentary canal is a common portal of entry for the virus in the several clinical types of poliomyelitis.

Inasmuch as the whole epidemiological picture dovetails very closely with the well-known habits, distribution, channels of migration and other ecological peculiarities of rats and their attendant fleas, a strong suspicion rests upon these animals. Whether it is a reality must await direct experimental evidence.

Since the precautionary measures most generally advocated to restrict the spread of poliomyelitis are based on the assumption of infection through personal contact, it is particularly urgent that the possibility of insect vectors receive discriminating attention and experimentation.

CHARLES T. BRUES

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⁷ *Boston Med. Surg. Journ.*, 175: 397-400, 1916.

THE FRUIT TESTING COOPERATIVE

THOSE of your readers who are interested in horticultural progress may not be aware that, unless it can expand its membership somewhat, the New York State Fruit Testing Cooperative Association may have to cease its useful work. The Fruit Testing Cooperative was organized some twenty years ago to serve as a bridge between breeders of new fruits and the testers of new fruits. Many varieties, apparently superior under the conditions where they are originated, prove to possess weaknesses when tested elsewhere. Certain members of the staff of the New York State Experiment Station conceived the notion of a cooperative association which would stand ready to test new varieties of fruit under a great variety of conditions, reporting back occasionally on the results of their tests. The resulting association has been self-supporting since its establishment, requiring no subsidy from any source whatsoever. It has served a useful purpose not only to the fruit breeders in exposing the flaws in some of their production, but to horticulture generally in speeding up the dissemination of worthwhile new productions. The cost of membership is nominal, and members buy the productions which they propose to test out at cost. But in order to continue self-supporting the cooperative must maintain the membership of at least 2,000 persons who are genuinely interested, on the one hand, in assisting the fruit breeders, and on the other hand in having access to the best new productions of the breeders for their own use. Persons interested in the work of the association should write to H. L. King, the manager, in care of the New York State Agricultural Experiment Station, Geneva.

PHILIP M. WAGNER

THE EVENING SUN,
BALTIMORE

NICOTINIC ACID

THERE has been much popular objection to the enrichment of bread with nicotinic acid, the vitamin necessary to prevent pellagra, because of confusion with the poisonous alkaloid, nicotine. In view of this objection the Food and Nutrition Board of the National Research Council recommends the acceptance of "Niacin" and "Niacin Amide" as synonyms for nicotinic acid and nicotinic acid amide. The committee which made the recommendation was composed of Drs. C. A. Elvehjem, W. H. Sebrell and Tom D. Spies. The committee also recommends that the terms nicotinic acid and nicotinic acid amide be used in scientific literature and that the new terms be used only where there may be objection from the public.

Elvehjem in 1937 discovered that nicotinic acid was a specific cure for black tongue in dogs. Spies and

others quickly extended Elvehjem's results to the cure of pellagra in man. The newly discovered vitamin, however, had been isolated more than 60 years earlier by treating nicotine with fuming nitric acid and named, therefore, nicotinic acid.

People unacquainted with chemistry but well aware of the deadly character of nicotine and of nitric acid taken separately, have not been able to understand how the combination of two poisons could produce a substance necessary to life and hence have opposed its use in food.

It is hoped that the word "Niacin" may be widely adopted and may allay popular misgivings as to the nature and effect of the anti-pellagra vitamin.

ROBERT F. GRIGGS

STOMATES? STIGMATES, STROMATES!

AT the time of the appearance of Meyer and Anderson's "Plant Physiology," I was somewhat disturbed at their use of the word "stomate" for what we used to call "stoma" but hoped that that usage would not become generally established. Listening to the papers at the recent A.A.A.S. meetings, however, it was evident that a number of people are beginning to use that form. A protest would seem to be in order before the word becomes too firmly entrenched.

Words may quite properly be anglicized if the change makes for easier, more general or more intelligent usage. I have no objection to saying "stoma, stomas." Nor is there any serious objection to modifying a Greek or Latin word if it is unwieldy. "Mitosis" is certainly preferable to the more exact form "mitoschizosis." But is there any possible excuse for taking the plural form of a simple, usable word like "stoma," forgetting that it is a plural, and anglicizing it into an unwieldy singular form like "stomate," and then building a new plural on top of it? That has about as much reason to it as saying "an eggs, two eggsses." The old form "stoma, stomas" or "stoma, stomata" was simpler, briefer, certainly as easy to remember. Those who say "stomate, stomates" probably would not think of saying "stigate, stigmates" instead of "stigma, stigmas (or stigmata)" or "stromate, stromates" instead of "stroma, stromas (or stromata)." Yet these have equal justification. If the reason back of this innovation is a phobia against foreign-language words, why not say "pores" or "little mouths" or "openings"?

Whatever the real basis is, a protest seems justified now before too many helpless students are seduced by this new form of technical jargon!

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SCIENTIFIC BOOKS

STATISTICAL REASONING

Elements of Statistical Reasoning. By ALAN E. TRELOAR, Ph.D. xi+261 pp. New York: John Wiley and Sons. 1939. \$3.25.

THIS is a presentation of fundamental principles of statistics, for readers whose mathematical preparation does not extend beyond elementary algebra. It is designed to explain the purpose, meaning and use of the most important measures of central tendency, dispersion, correlation, statistical significance and goodness of fit. Its aim is the thorough elucidation of those ideas which are of primary importance, rather than superficial treatment of a multiplicity of special topics.

Although nearly half of the book is concerned directly or indirectly with the study of errors of random sampling, detailed discussion of "small-sample techniques" is reserved for another volume. The emphasis here is on the conditions under which the various special forms of frequency function are sufficiently approximated by normal distributions. While full value is ascribed to the significance of the more elaborate analysis in the cases for which it is required, there is no concealment of the conviction that a good big sample is better than a good small sample.

While not technically mathematical beyond the level indicated, the book is not intended for readers who are unable or unwilling to do the kind of accurate thinking which mathematics is designed to facilitate. It is of serious interest to the more advanced student as an essay in determining the extent to which language can be made to supplement or replace mathematical formalism in the precise expression of quantitative ideas. Within the bounds set for the project, anything that can not be formulated in terms of elementary algebra has to be put into words. Naturally there are limits to what can be accomplished in this way; on the other hand, any array of formulas requires the illumination of verbal analysis, and this may well precede detailed study of the formulas themselves, even for a student who is prepared to undertake the latter. It is apparent on every page that the author is in the habit of compelling words to say exactly what he wants them to say, not of tolerating any irresponsibility on their part, and they are made to convey abstract ideas with a surprising degree of definiteness. Rarely they are allowed a moment's deliberate relaxation, as in the reservation, "if sex and goodness are independent," in connection with the multiplication of probabilities, or in the remark in the chapter on vital statistics that "those who die cease to be reporters of events to any terrestrial government." There are a few lapses, a few passages less

clearly organized than the rest, and a few places where the reader may be led to think that he is expected to understand immediately something which in fact requires extended explanation; but in general the standard of expression is high. Quotable sentences are numerous.

The illustrative examples are carefully selected and thoroughly explained. While they are mostly taken from biological settings, the numerical data and statistical principles involved are so clearly set forth that the reader whose interest is in other fields of application will have no difficulty either in comprehending them or in adapting their essential features to his own work. The diagrams and tables are gratifying to the eye as well as to the understanding.

The typography is generally excellent. A few errors have been noted. The number 54.125883 in the table on page 57 should be 54.135883; and an exponent 2 is missing in the same panel. The minus sign in the square root on page 140 should be plus; the correct formula appears on the next page. The value of P on page 223 should be .24 instead of .30.

This book will repay careful reading even by students of considerably more technical advancement than those for whom it is primarily designed to serve as an introductory text.

DUNHAM JACKSON

ANALYTICAL CHEMISTRY

Chemical Analysis. A Series of Monographs on Analytical Chemistry and its Applications. Vol. II. Chromatographic Adsorption Analysis. By HAROLD H. STRAIN. 222 pages; one colored plate; 37 illustrations. New York: Interscience Publishers, Inc. 1942. \$3.75.

THIS excellent analytical handbook covers its important field admirably, both qualitatively and quantitatively. Chromatographic adsorption analysis has become an indispensable adjunct for the final separation of mixtures difficult or impossible to resolve by any other method.

Originally introduced by the botanist Tswett, for the separation of plant pigments, it has been eagerly seized upon, particularly by the organic and biological chemists, for the solution of many extremely troublesome problems of purification. Yet the operations involved are relatively simple and the equipment inexpensive.

A most appropriate colored plate constitutes the frontispiece. It depicts the appearance of two adsorption columns; one showing the separation of carotenes, and the other that of the xanthophylls, with

their characteristic so-called "chromatograms," or series of colored bands. The illustrations in the text are well chosen and most helpful. As the author states in his preface, the "major emphasis has been placed upon experimental procedure," and the information supplied in this direction is exceptionally full and critically presented. Following the Historical Introduction (9 pp.), are chapters on the Applications of Chromatographic Adsorption Methods (20 pp.), Apparatus and Procedure (18 pp.), Adsorbents (18 pp.), Solvents and Eluants (6 pp.), and Location of Colorless Adsorbed Substances (6 pp.).

As might be expected, chromatography has not found so many applications in the case of Inorganic Compounds (8 pp.). In the field of Organic Compounds (70 pp.), it has rendered the greatest service—simple aliphatic and aromatic substances, homo-

cyclic and heterocyclic compounds, sterols and related compounds, vitamins, hormones, enzymes, co-enzymes, proteins, anthocyanins, pterins, chlorophylls, hemoglobin derivatives, bile pigments, carotenoids, coal-tar dyes and various natural substances. The volume closes with a résumé of the Industrial Uses (8 pp.) to which the method has been put.

An elaborate Table of Contents makes clear the helpful way in which the subject-matter is organized and presented, and this is supplemented by both an Author Index and a Subject Index. By no means the least valuable feature of the work is a Bibliography covering 42 pp.

The book is heartily commended to all chemists interested in this method of analysis.

MARSTON TAYLOR BOGERT

COLUMBIA UNIVERSITY

SOCIETIES AND MEETINGS

THE UNION OF AMERICAN BIOLOGICAL SOCIETIES

THE annual meeting of the Council of the Union of American Biological Societies was held in Dallas, Texas, on Monday, December 29, at 4:00 in the afternoon.

As in the past the Union has been concerned with a number of items of general interest to biologists throughout the country. One of the primary concerns of the organization has been *Biological Abstracts*. Dr. John E. Flynn, editor-in-chief of this journal, reported to the Union that the Abstracts for Volume 15 showed a 45 per cent. greater number of abstracts than Volume 14. He furthermore pointed out that whereas 1,105 periodicals were being abstracted in March, 1941, 1,550 periodicals were being abstracted in December of that year, a net increase of 445. A special effort has been made to arrange for the abstracting of foreign journals, many of which are now difficult or impossible to procure in this country. The steadily increasing cost of publication of the abstracts was pointed out, but it was explained that since, of course, *Biological Abstracts* was a non-profit organization, all money which has become available has been used as efficiently as possible to maintain and improve the journal. It was assured that when more money would be made available, *Biological Abstracts* would be correspondingly enlarged and improved. It was stated that the Abstracts had operated without a continuing deficit in the past, but that this could no longer be done now that all foreign subscriptions except those of South America and the British Empire were most probably lost. Dr. Flynn called the attention of the council, however, to certain encouraging signs, namely,

the significant increase in subscriptions by United States and Latin American biologists. Since spring the number of subscriptions of the latter group had increased 100 per cent. or more. Despite the fact that American biologists are becoming increasingly aware that *Biological Abstracts* is their own instrument, this journal still needs much greater support in the form of individual subscriptions before it can become as complete as biologists would wish it to be.

The council unanimously approved a plan to have the president of the Union appoint a committee to study the possibilities for expansion of interest in, and cooperation with, *Biological Abstracts* by the Latin-American countries.

Beginning January, 1942, *Biological Abstracts* is establishing a sixth section, Section F, entitled, "Animal Production and Veterinary Science." This has been done in order to provide for the needs of men employed in the animal industries.

A second general project with which the Union has been concerned is aid to the National Central Library of China. This project has recently been almost completely at a standstill, due to the war in the Far East.

Through one of its committees composed of E. V. Cowdry, F. L. Fitzpatrick, H. B. Glass, B. C. Gruenberg, O. Riddle and E. W. Sinnott, the Union has been investigating for a number of years biological science teaching in secondary schools. The final report of this committee was made by its chairman, Dr. Oscar Riddle. Two preprinted copies of the 76-page report were submitted to the Union Council. This report contained an analysis of 3,186 returns on a questionnaire sent to teachers of biology in secondary schools. Dr. Riddle stated that five of the six segments of this report had already been published earlier in the

American Biology Teacher. The sixth segment will appear in the January issue of that journal. Seven thousand copies of the complete report, entitled, "The Teaching of Biology in Secondary Schools of the United States—A Report of Results from a Questionnaire," are in press, and arrangements have been completed for mailing copies to biologists, educators and others throughout the United States.

Dr. Oscar Riddle, Carnegie Institution, Cold Spring Harbor, and Dr. Walter F. Loehwing, University of Iowa, were appointed to serve as representatives of the Union of American Biological Societies upon the recently formed "Cooperative Committee on Science Teaching." This latter committee also has representatives from the American Association of Physics Teachers, the American Chemical Society, the Mathe-

matical Association of America and the National Association for Research in Science Teaching. This joint committee plans to consider certain problems (see *SCIENCE*, Vol. 95, p. 38, 1942) relating to the teaching of science in secondary schools.

The following officers were elected to serve for the Union of American Biological Societies during 1942: *President*, A. J. Carlson, University of Chicago; *Secretary*, F. A. Brown, Jr., Northwestern University; *Treasurer*, D. H. Wenrich, University of Pennsylvania; *Executive Committee*, B. M. Duggar, University of Wisconsin; A. P. Hitchens, University of Pennsylvania; G. W. Hunter, III, Wesleyan University.

FRANK A. BROWN, JR.,
Secretary

UNION OF AMERICAN BIOLOGICAL SOCIETIES

SPECIAL ARTICLES

THE PROCARCINOGENIC EFFECT OF BIOTIN IN BUTTER YELLOW TUMOR FORMATION¹

EARLY in 1940 during the course of investigations which led to the demonstration^{2,3,4} that biotin is identical with the anti-egg white injury factor (vitamin H), and that biotin is thus functionally involved in animal metabolism, experiments were initiated to ascertain whether or not biotin is a dietary factor present in liver and yeast which is protective against primary carcinoma of the liver induced in rats by the administration of N,N-dimethylaminoazobenzene (butter yellow). Protection against butter yellow by liver and yeast supplements had been reported by the Japanese workers.^{5,6}

In two preliminary experiments two very crude biotin preparations, one from liver and one from yeast, were used as supplements to the butter yellow-brown rice-carrot basal diet which alone gave regularly a high incidence of tumors, namely, 96 per cent. at 150 days. Indications of a protective effect were obtained.

Other studies on protection against butter yellow

¹ Acknowledgment is made with full appreciation to Dr. Paul György for the crude liver concentrates used in these experiments and to the S.M.A. Corporation for supplies of biotin concentrates which made this investigation possible. A grant in support of this work to one of us (C.P.R.) from Standard Brands, Inc. is also gratefully acknowledged.

² P. György, D. B. Melville, D. Burk and V. du Vigneaud, *SCIENCE*, 91: 243, 1940.

³ V. du Vigneaud, D. B. Melville, P. György and C. S. Rose, *SCIENCE*, 92: 62, 1940.

⁴ P. György, C. S. Rose, K. Hofmann, D. B. Melville and V. du Vigneaud, *SCIENCE*, 92: 609, 1940.

⁵ W. Nakahara, K. Mori and T. Fujiwara, *Gann*, (a) 32: 465, 1938; (b) 33: 13, 1938; (c) 33: 406, 1939; (d) 33: 57, 1939.

⁶ T. Ando, *Gann*, 32: 252, 1938.

revealed at this time that the addition of 200γ of riboflavin and 18 per cent. casein to the brown rice-carrot basal diet gave marked protection.⁷ The tumor incidence at the end of 150 days was decreased from 96 per cent. to 7 per cent. This effect, though marked, was not as complete as that obtained by supplements of dried liver or yeast. Accordingly, the effect of the

TABLE I
DIETS EMPLOYED

	Diet A*	Diet B	Diet C*
Brown rice	82 per cent.	15 per cent.	81.5 per cent.
Casein (vit. free) ..	18 " "	18 " "	18 " "
Crisco	10 " "	10 " "	10 " "
Sucrose (C.P.)	60 " "	60 " "	60 " "
Egg white (dried) ..	10 " "	10 " "	10 " "
Cystine	1 " "	1 " "	0.5 " "
O. M. salt mixture ..	4 " "	4 " "	4 " "

Supplements—Amounts per 100 grams of diet

	Diet A*	Diet B	Diet C*
Choline	250 mg	250 mg	160 mg.
Riboflavin†	1 mg	2 " "	2 " "
Thiamin	0.5 " "	0.5 " "	0.5 " "
Pyridoxine	1 " "	1 " "	1 " "
Nicotinic acid	5 " "	5 " "	5 " "
Inositol	100 " "	100 " "	100 " "
Pantothenic acid ..	2.5 " "	2.5 " "	2.5 " "
Vit. A (concentrate) ..	4000 units	4000 units	4000 units
Vit. K (Me Naphthoquinone)	0.5 " "	0.1 mg	0.1 mg
Vit. E (dl, α-tocopherol)	1.0 " "	1.0 " "	1.0 " "
Irradiated ergosterol ..	400 units	400 units	400 units
Ergosterol	100 " "	100 " "	100 " "
N,N-dimethylaminoazobenzene	60 " "	100 mg	60 " "

* When diets A and C were used 1 gram of carrot was given per rat per day as used by R. Kinoshita, *Trans. Japan. Path. Soc.*, 27: 665, 1937.

† 0.5 mg added in Diet B instead of 2 mg from 1st through 45th day.

⁷ C. J. Kensler, K. Sugiura, N. F. Young, C. R. Halter and C. P. Rhoads, *SCIENCE*, 93: 308, 1941. On the basis of independent investigations, P. György, C. E. Poling and H. Goldblatt (*Proc. Soc. Exp. Biol. and Med.*, 47: 41, 1941), have also obtained a protective effect of casein in the presence of riboflavin.

addition of other members of the B complex vitamins plus ergosterol and vitamin K, as given in Diet A, Table I, was next studied. Results shown in Table II indicate that these additional vitamins did not improve significantly the protection afforded by the riboflavin-casein supplement to the brown rice diet. In the hope of obtaining still more complete protection, several groups of animals were fed in addition to Diet A, 0.3 and 1.0 γ of biotin respectively in the form of two concentrates, one 0.1 per cent. pure and the other (biotin ester) 25 per cent. pure. These animals appeared, however, to be less protected. Tumors were found in only 1 of the 9 animals on Diet A, whereas tumors were found in 13 out of 34 rats which had been given the biotin supplements in addition to Diet A.

TABLE II

EFFECT OF BIOTIN ON THE PRODUCTION OF HEPATIC TUMORS BY N,N-DIMETHYLAMINOAZOBENZENE

Exp. No. Diet	Biotin prep. used	Amount of biotin added daily	No. days on diet	No. rats surviving	No. rats with hepatic tumor
I A	0.1 per cent. conc.	0.3 γ	150-230	9	1
A	25 " " (ester)	0.3 "	" "	8	3
A	0.1 " " (ester)	1.0 "	" "	9	3
A	25 " " (ester)	1.0 "	" "	8	4
II B	.....	2.0 *	180	5	0
B	crystalline	2.0 "	"	5	3
III C	.....	2.0 "	150-210	14	0
C	crystalline	2.0 "	"	11	6
SUMMARY OF RESULTS					
Exp. I, II, III	Controls	.....		28	1
	Crude and crystalline biotin	0.3-4.0 γ		50	22
Exp. II, III	Controls	.....		19	0
	Crystalline biotin	2.0-4.0 γ		16	9

* 4.0 γ crystalline biotin were fed from the 45th to the 115th day.

In view of this unexpected result, a further study was made of the effect of biotin added to highly protective diets. Crystalline biotin was used. Since only a limited amount of this material was available, the study was restricted to a small number of animals. A supposedly highly protective diet containing casein supplemented with cystine and choline was employed and sufficient egg white was added to produce a borderline biotin deficiency. It is to be noted that this diet did not contain the brown rice. The other constituents of the diet are shown in detail under Diet B, Table I. One group of animals was fed this diet alone and another group received in addition 2.0 γ of crystalline biotin daily except from the 45th to the 115th day where 4.0 γ were given daily. As is shown in the table, no tumors were found in the low biotin group at 6 months, whereas hepatomas were found in

3 out of 5 rats which had received the crystalline biotin.

While this experiment was in progress another experiment was made with the brown rice-carrot diet as the basal ration. Riboflavin, casein, cystine and choline were added (Diet C, Table I). No liver tumors were present at 150 to 210 days.⁸ On the other hand, 6 animals out of 11, which in addition to Diet C had been given 2 γ of crystalline biotin daily throughout this experimental period, showed well-developed neoplasms when sacrificed.

Thus in 3 sets of experiments in which rats were maintained on diets affording a high degree of protection, crystalline biotin and two biotin concentrates were found to "break through" the protection.⁹ Moreover, this effect was obtained on two radically different diets; in one experiment no rice was used and in two a rice diet was employed. A combination of the data of these 3 experiments shows that only 1 rat out of the 28 control animals developed a liver tumor. However, when biotin (0.3 to 4.0 γ) was added to these 3 diets, 22 rats out of a total of 50 developed liver tumors. A combination of the data of the 2 experiments in which crystalline biotin was used shows that, whereas there were no tumors in the controls (19 rats), 9 out of 16 rats fed the biotin had tumors. The preliminary experiments in which some protection was provided by the crude biotin preparations suggest the possibility that these crude preparations may also contain a factor which affords a small amount of protection which becomes apparent when a largely non-protective diet is used.

We feel that the results presented here justify the conclusion that biotin can exert a procarcinogenic effect when butter yellow is fed to rats receiving a highly protective diet. Whether biotin can break down the protection against butter yellow afforded by a yeast or liver supplement; whether the procarcinogenic action we have observed under our experimental conditions is a unique property of biotin; whether the effect can be extended to other carcinogenic agents and other species; and whether the reversed effect can be produced by a biotin deficiency (egg-white, avidin or other means), must all await further experimentation. The present data throw no light on these ques-

⁸ A detailed report of our experiments investigating the protection afforded by riboflavin, casein, methionine, cystine and choline will appear at a later date.

⁹ We have learned through private communication that György, Landy and Goldblatt have obtained with the biotin concentrate from liver (0.1 per cent. pure) a similar procarcinogenic biotin effect using a significantly protective diet. They found in an experiment involving 50 test and control rats that when 0.8 to 3.5 γ of biotin were administered daily to rats on a diet consisting of cooked polished rice and carrot supplemented daily with 20 γ of riboflavin, B₁, and B₆, tumor incidence was increased at 150 days from 33 to 52 per cent.

tions. We forego any discussion of the possible significance of the finding reported herein until further experimental data on these and related aspects are forthcoming.

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PRELIMINARY OBSERVATIONS ON "EGG WHITE INJURY" IN MAN AND ITS CURE WITH A BIOTIN CONCENTRATE^{1,2}

It seemed important to determine whether any of the manifestations of spontaneous avitaminosis in human beings might be related to biotin deficiency. To this end a small group of volunteers ate a diet planned to contain a minimal amount of biotin; to this was added desiccated egg white in amounts sufficient to furnish approximately 30 per cent. of the total caloric intake. The diet was composed of 125 gm of polished rice, 80 gm of patent white flour, 75 gm of farina, 205 gm of cane sugar, 32 gm of lard, 10 gm of butter washed five times in hot water and 25 gm of lean beef. To this was added 200 gm of dehydrated but otherwise unmodified egg white. The basal components contained approximately 387 gm of carbohydrate, 31 gm of protein and 32 gm of fat with a caloric value of 1,960; the egg white contained 160 gm of protein and 32 gm of fat with a value of 928 calories. Such a diet is extremely poor in vitamins except riboflavin which is present in egg white in amounts approximating 10 mg per 100 gm. The daily vitamin supplement was:

Thiamin chloride	6 mg
Riboflavin	9 mg
Nicotinic acid	75 mg
Pyridoxine	5 mg
Ca. pantothenate	5 mg
Ascorbic acid	75 mg
Vitamin A	5,000 units

In addition, 1 gm of ferrous sulfate and 1 gm of calcium lactate were given daily.

It was possible to continue four subjects under ob-

¹ From the University of Georgia School of Medicine and the University Hospital, Augusta, Ga., and the Division of Chemotherapy, National Institute of Health, Bethesda, Md.

² This investigation was made possible by grants-in-aid by the John and Mary R. Markle Foundation and an anonymous donor and by donations of vitamins by many manufacturers. We gratefully acknowledge the constant help and valuable suggestions of Dr. R. E. Butler and the technical assistance of Mrs. Marjorie Bee.

servation to a satisfactory conclusion; three were white men, one a Negro woman. During the third and fourth weeks all four developed a fine scaly desquamation without pruritus. This disappeared spontaneously in seven to ten days. Thereafter nothing of significance was noted until the seventh week when one man developed a maculosquamous dermatitis of the neck, hands, arms and legs. During the seventh and eighth weeks all showed a pronounced grayish pallor of the skin and mucous membranes which was out of all proportion to the blood picture. During this same period the white patients showed atrophy of the lingual papillae, it was notable that the tongues remained pale with none of the capillary engorgement seen in pellagra or ariboflavinosis. During the ninth and tenth weeks all subjects showed increasing dryness of the skin with marked reticulation and a return of fine branny desquamation. No ocular or genital lesions were observed.

After the fifth week symptoms were prominent; these were strikingly like those noted in experimental thiamin deficiency. Mild depression progressed to extreme lassitude, somnolence and in two instances a mild panic state. Muscle pains, hyperesthesia without demonstrable neurologic changes and localized paresthesias were complained of by all. After the tenth week anorexia occurred with occasional nausea. Two patients complained of precordial distress and showed definite electrocardiographic changes.

Examinations of the blood at frequent intervals showed a definite diminution in hemoglobin content, the number of erythrocytes and the volume of packed red cells, there was slight increase in bile pigments and striking rise in the serum cholesterol. Determinations of biotin excretion in the urine showed that after seven to eight weeks of the experimental regimen the subjects excreted from 3.5 to 7.3 micrograms of biotin in 24 hours as compared with 29 to 52 micrograms excreted by individuals taking a normal diet.³

Treatment with an injectable biotin concentrate⁴ has been completed in three of the four volunteers. The daily dose, administered in three aliquots, has varied from 75 to 300 micrograms; 150 micrograms seemed the minimal amount required for prompt relief. Depression, muscle pains, precordial distress and anorexia were abolished on the third to fifth days of treatment. Active distaste for the diet was replaced by willingness, even eagerness to eat it, although there was no significant increase in the amount consumed. The striking ashy pallor of skin and mucous membranes disappeared in four days. The elevated level of serum cholesterol was significantly reduced after

³ Biotin determinations made by Dr. H. Isbell, of the National Institute of Health.

⁴ Biotin concentrate supplied by the S.M.A. Corporation, Chagrin Falls, Ohio.

one week. Insufficient time has elapsed for evaluation of other evidences of correction of physiologic disturbances.

Immediately after administration of 150 micrograms of biotin concentrate the urinary excretion rose from a deficiency level of 3 to 5 micrograms of biotin a day to a level approximating 55 micrograms. This excretion was maintained until the dose was increased to 300 micrograms when there was a further step-like increase in biotin excreted to 140-150 micrograms. When medication was discontinued there was an immediate fall in excretion to a level slightly lower than that found in persons eating a normal diet.

SUMMARY AND CONCLUSIONS

It has been possible to maintain human volunteers on a diet extremely poor in vitamins and in which

approximately 30 per cent. of total calories was supplied by desiccated egg white. This was supplemented by seemingly adequate amounts of vitamins, iron and calcium. These individuals developed definite symptoms and signs, some of which were strikingly similar to those of spontaneous avitaminosis.

Symptoms and signs were rapidly cured by the parenteral administration of a biotin concentrate in doses representing 150 to 300 micrograms of biotin per diem.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

MICROBURETTE

THE principle of operation of the burette is that mercury is displaced by the spindle of a micrometer or by smaller spindles replacing the original. Moving an ordinary micrometer spindle through 25 mm displaces around $\frac{3}{4}$ cc, which is precisely divided into 2,500 parts. Since the measurement is based on the displacement of dry mercury, it is not affected by the amount of solution which adheres to the walls of the burette.

The anvil of the micrometer is replaced with a set screw (1). The lower part of the burette is a cylindrical reservoir with a plane ground, thick bottom and plane ground opening and an internal diameter just enough to clear the spindle. On the closed end of the reservoir is stuck a fiber ring (2) and next that a steel disk (3) with a center punch to receive the set screw. To the open end is stuck a fiber washer (4) greased with a heavy stopcock grease. The reservoir is fastened in the micrometer frame. Mercury will not leak through the spindle bearing when it is properly greased. If a small spindle is used, the fiber washer (4) must be reamed to a perfectly tight fit around the spindle which will be proof against leakage of mercury.

The micrometer frame is clamped to a convenient stand and mercury is sucked in to fill the reservoir. It is essential for calibration that no air bubbles remain in the reservoir. The last traces can be removed by applying vacuum suction to the burette tip. When the spindle is screwed out flush with the fiber washer, the enlarged bubbles can then readily be brought up into the funnel-shaped opening to the capillary. The reservoir is air free when there is no visible bouncing of the capillary column of mer-

cury when the micrometer spindle is quickly moved and when no deviation from a mark occurs if the burette is tilted from vertical to horizontal.

For relative calibration it is convenient to have two ringmarks (5, 6) on the burette capillary at the same level. The volume between the marks is read on the micrometer by moving the mercury meniscus

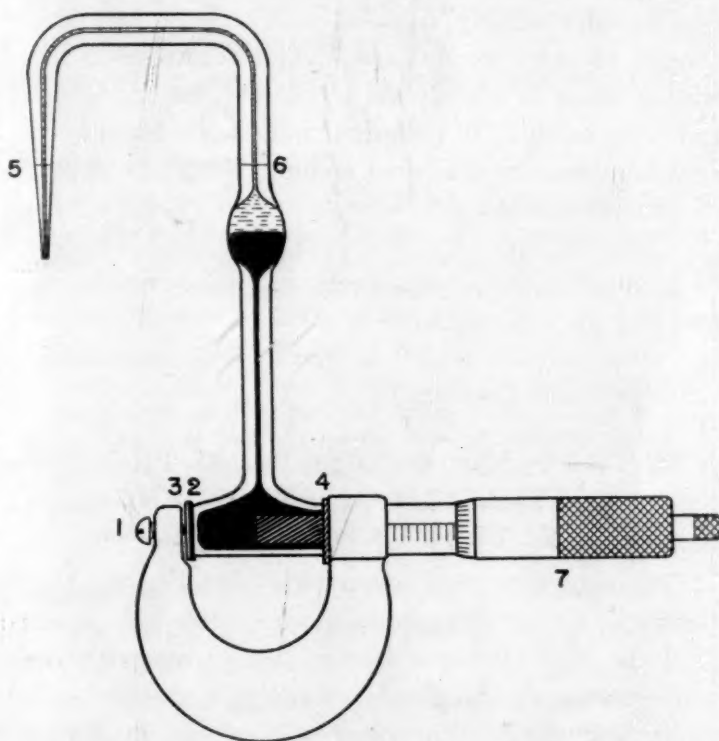


FIG. 1

from one mark to the other in the dry burette. Some mercury is discharged and a new measurement taken, until the whole range has been tested.

The micrometers tested at our laboratory always came out with an accuracy corresponding to one fifth of the smallest divisions of the micrometer, i.e., as

close as could be estimated. Using the ordinary spindle this corresponds to an overall accuracy of around $1/10 \text{ mm}^3$ which amount corresponds to around one part in 10,000 of the total delivery capacity of the burette. The total capacity is determined by weighing the mercury delivered by full extension of the spindle. Temperature instability is practically avoided if the volume of the instrument is kept as small as possible. With considerate handling a water-jacket is not necessary.

The solution to be used is sucked into the bulb as shown in the figure and the instrument is ready for use. The size and shape of the burette can be varied according to the special purpose. It is an advantage that it is immaterial for the accuracy of the instrument how quickly the solution is delivered, for the measurement is not affected by solution which sticks to the walls of the capillary.

By replacing the original spindle with a drill rod of smaller diameter the total volume delivered can be reduced to very small limits and still permit accurate measurement of $1/10,000$ part. For such a purpose the spindle and screw of the micrometer is first loosened from the thimble (7). The spindle is cut off and in its place is fastened by press fit a carefully alined drill rod of the requisite diameter. An accurate bushing is fitted in the original spindle bearing. The reservoir and washers of this smaller burette are correspondingly smaller, with a bore just large enough to clear the drill rod. The burette bulb likewise is made to correspond to the volume of the drill rod. By using $1/16$ inch drill rod such a burette was found to measure delivered amounts with an accuracy of around $1/200 \text{ mm}^3$.

A microburette of this type is to be described later as part of a micro gas analyzer. The burette was made by J. D. Graham.

P. F. SCHOLANDER

SWARTHMORE COLLEGE

A METHOD FOR DETERMINING THE CONCENTRATION OF PROPYLENE GLYCOL VAPOR IN AIR

THE discovery that propylene glycol vapor, dispersed in air in very minute concentrations, is capable of destroying air-borne bacteria and viruses^{1,2,3} has made necessary the development of a technique for estimating the concentration of this gas in the air. A satisfactory procedure has been found to consist

¹ O. H. Robertson, Edward Bigg, B. F. Miller and Z. Baker, *SCIENCE*, 93: 213, 1941.

² O. H. Robertson, Edward Bigg, B. F. Miller, Z. Baker and T. T. Puck, *Transactions of the Association of American Physicians*, 1941. In press.

³ O. H. Robertson, Clayton G. Loosli, Theodore T. Puck, Edward Bigg and Benjamin F. Miller, *SCIENCE*, 94: 612, 1941.

of bubbling 2-liters of the air through 10 cc of water with the aid of a sintered glass filter, and analyzing the propylene glycol content of the resulting solution by the method of Lehman and Newman,⁴ modified to accommodate the smaller concentrations involved.

An efficient gas disperser can be made by sealing a circular disk cut from a fairly coarse fritted glass filter, into a glass tube, or can be bought from commercial supply houses. Complete absorption of the propylene glycol is obtained when the rate of sampling does not exceed $1/5$ liters of air per minute. If rubber connections are used, the two glass tubes should touch inside the connector, as propylene glycol is quite soluble in rubber.

The contents of the test-tube are quantitatively washed into an Erlenmeyer flask. 1.00 cc of M/10 sodium periodate is added, and the sample is placed in an icebox for 15 minutes. At the end of that time, 5 cc of 7 per cent. NaHCO_3 is added, then 2.500 cc of N/10 Na_3AsO_3 , followed by 0.2 cc of freshly prepared 20 per cent. KI. The solution is allowed to stand for 15 minutes at room temperature, after which 1 cc of 1 per cent. starch solution is added, and the solution titrated with 0.01N I_2 solution. A blank is run through the same procedure, and the number of milliliters of I_2 solution used in the blank is subtracted from that required by the sample. One cc of .01N I_2 solution is equivalent to 0.38 mgs of propylene glycol.

This procedure has been checked by analysis of samples of air into which known amounts of the glycol have been vaporized. The method is accurate to within .05 mgs of propylene glycol in the analyzed sample. When very dilute mixtures of propylene glycol are being determined (0.1 mg per liter or less), it is therefore necessary to use 4 to 6 liters of air for each sample.

THEODORE T. PUCK

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⁴ A. J. Lehman and H. W. Newman, *Jour. Pharmacology and Experimental Therapeutics*, 60: 312, 1937.

BOOKS RECEIVED

- ENGELDER, CARL J. *Elementary Qualitative Analysis*. Third edition. Pp. x + 344. Illustrated. Wiley. \$2.50.
- HAYNES, WILLIAMS. *This Chemical Age*. Full color photographic illustrations. Pp. vii + 381 + xxii. Alfred A. Knopf. \$3.50.
- LEE, CLARENCE E. *Profitable Poultry Management*. Eleventh edition. Illustrated. Pp. 180. Beacon Milling Co.
- RICHTMYER, F. K. and E. H. KENNARD. *Introduction to Modern Physics*. Third edition. Pp. xv + 721. McGraw-Hill. \$5.00.
- SHUMWAY, WALDO. *Introduction to Vertebrate Embryology*. Fourth edition. Illustrated. Pp. xi + 372. Wiley. \$4.00.
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SCIENCE NEWS

Science Service, Washington, D. C.

THE DISTRIBUTION OF NATURAL RESOURCES

THE collective organization of all human beings into some form of world community, with a planned coordination of human activities of all sorts, was predicted as a result of the war by Dr. Kirtley F. Mather, professor of geology at Harvard University, who spoke on January 28 at the Cranbrook Institute of Science at Bloomfield Hills, Mich. He pointed out that "Regardless of the outcome of the present World War, the old order will inevitably be replaced by a new order that is even now being forged on the ringing anvil of history. This organization of individuals into a world society is the inevitable consequence of the extensive use of natural resources that are unevenly distributed over the face of the earth. The ceaseless flow of things from mine and quarry, field and forest, to processing plants, mills and refineries and thence to consumers is a fundamental necessity in an age of science and technology."

Dr. Mather said that it is quite likely that the historian of the future will rate this middle third of the twentieth century as equal in significance to the closing third of the fifteenth century. To-day, just as in that ancient time, human civilization is moving from an era that is closing into a new era that is opening. There is actually an abundance of the needed raw materials. A careful appraisal of the world stores of non-renewable resources, including known substitutes for such resources as petroleum that are known to be present in insufficient amounts, reveals the fact that there is enough and to spare of all the necessary raw materials to provide the physical basis for the efficient, comfortable existence of every human being who is likely to be born anywhere on the earth during the next two thousand years at least.

"Science and technology are even now inaugurating a new relationship between man and the things he needs or thinks he needs. For a century or more the tendency has been to use more and more of the non-renewable resources, nature's stored capital, and relatively less of the renewable resources, man's annual income. For example, between 1900 and 1925 we used up more of the world's resources of the various metals and mineral fuels than had been used by man throughout his entire history prior to the year 1900. But within the last decade, scientific research has reversed the trend. The expanding chemical industries with their plastics and synthetic resins depend largely upon things that grow, and these are a product of the potentially inexhaustible resources of the soil. Long before the capital stored by nature throughout geologic time has been exhausted, man may well have learned how to live within his annual income. Thanks to discovery and invention, it may be truly practical literally to beat our swords into ploughshares, our spears into pruning hooks. Mother Earth is rich enough to nourish every man in freedom. It is man, not nature, that enslaves. The question whether it is better to starve as a free man or grow fat as a slave has often been a difficult one to an-

swer, but that question need never arise if men use intelligence and good will in determining the relation between the individual and society."

TELESCOPE FOR THE NEW NATIONAL ASTROPHYSICAL OBSERVATORY IN MEXICO

THE second largest telescope for Latin America is rolling down to Mexico by truck after having been inspected by the staff of the Mexican Embassy. At dawn on January 31 this new and modern telescope left the Harvard Observatory, where it was built, with Dr. Harlow Shapley, director of the Harvard Observatory, driving the first lap of its long journey to a hill in the ancient valley of Cholula near Puebla, Mexico.

There the new telescope will go into service in the new National Astrophysical Observatory as a symbol of the spirit of Inter-American cooperation. Its dedication by President Avila Camacho on February 17 will be the occasion of an Inter-American Scientific Conference.

The new telescope is of the Schmidt type that is more effective for the exploration of the universe of stars and galaxies than more conventional instruments of much larger size. Its spherical mirror has a diameter of 31 inches while the correcting lens of 27 inches diameter insures excellent star images over a large range of sky.

The only larger instrument in Latin America is the 60-inch reflecting telescope of the Argentine National Observatory at Cordova, but the new Mexican instrument because of its more modern design will do several types of work better than the Argentinian telescope.

Despite war priorities and labor shortages, the new telescope was built in the record time of six months. The mirror and plate are optically accurate to within a few millionths of an inch. The mounting of duraluminum and cast iron weighs 4,500 pounds and consists of a tube fourteen feet long and four feet in diameter and a polar axis of 11 feet.

It was planned that the truck should be met at Laredo, Texas, by Professor Luis Enrique Erro, director of the new Mexican Observatory, and sped to Tonanzintla so that the telescope might be installed for the dedication.—WATSON DAVIS.

THE NEW WHIPPLE COMET AND THE TOTAL ECLIPSE OF THE MOON

WHEN the moon is totally eclipsed on March 2, a good view of the new comet just discovered by Professor Fred L. Whipple will be possible through even a small telescope.

Computations at Harvard Observatory, where the comet was discovered, showed that the comet is headed for the place in the sky where the moon will rise on the early evening of Monday, March 2, eclipsed by the sun. With the moon's light thus shielded, a good look at the Whipple comet, a little west of the moon, will be possible, although the moonlight a few days before and afterwards will blot it out.

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As an extra attraction there will be an occultation, or a covering of a bright star, the 5th magnitude object called 59 Leonis, which is much brighter than the comet (which will be about 8th magnitude).

This triple attraction is expected to cause almost all amateur astronomers with small telescopes, many of them made by themselves, to go into action that evening.

Whipple comet is at present in constellation Coma Berenices in northeastern sky in the evening. On February 19 the comet will pass close over or just north of second magnitude star Denebola in the tail of Leo the Lion. Denebola rises about 9 P.M. EWT, on February 15, fifteen degrees north of east. Astronomers can not predict whether or not the comet will reach naked-eye visibility, but the chances are against it doing so.

At present the comet is of the ninth magnitude, visible only in two-inch refractor or six-inch reflector. An amateur would probably need a chart to find it. On February 19 the comet will be of the eighth magnitude and about March 15 it will be seventh magnitude, which is still far below naked-eye visibility for comets.

The comet will pass closest to the sun April 30 at a distance of 135,000,000 miles. It is coming down into our system at a high angle, nearly 80 degrees, which means that it will plunge through the plane of the ecliptic, then shoot up and out again.

FURTHER PAPERS READ AT THE DALLAS MEETING OF THE AMERICAN ASSOCIATION

Bigger yields of a number of field crops were obtained by treating their seed before sowing, and in some instances by spraying the plants in the field, with plant hormones or growth-promoting substances, in large-scale tests reported by Professor J. C. Ireland, of Oklahoma Agricultural and Mechanical College. Of special potential practical interest is the fact that the stimulant he found most valuable, levulinic acid, can be made cheaply from waste materials. Its most important present use is in the making of plastics. "The most outstanding results with levulinic acid were obtained in the treatment of cotton seed and cowpeas. The results show that there is not only more than a 50 per cent. increase in the yields over the untreated but that dusting with soyflour and 1 per cent. levulinic acid during the flowering period aids in the setting of bolls." An acre of cotton thus treated would yield 838 pounds, worth about \$134, as compared with a yield from an acre of untreated crop of only 581 pounds, worth \$93. Cost of materials for treating one acre with levulinic acid is about \$3, so that the method appears to be commercially profitable.

A coconut served as foster-mother to embryo plants much as a cow or goat serves as foster-mother to infants of our own species, in experiments reported to the American Society of Plant Physiologists by Dr. J. van Overbeek, of the California Institute of Technology. Inducing very small plant embryos to grow outside their seeds is a feat comparable in difficulty with growing chick embryos outside their eggs. Working in cooperation with Dr.

Marie E. Conklin, of the Brooklyn Botanic Garden, and Dr. A. F. Blakeslee, of the Carnegie Institution of Washington, Dr. van Overbeek succeeded in getting them to grow in glass laboratory dishes, feeding them on a solution of nutrient chemicals. At first the embryos would not grow. Recalling the physiological function of the milk in the coconut, in feeding the embryo of the coconut palm, he decided to add some coconut milk to his nutrient medium. It worked. The embryos he reared were those of jimsonweed. He succeeded in carrying them through from specks about the size of a pinpoint to a diameter of nearly a quarter of an inch, in six days' time. After a week in the coconut-milk-enriched fluid medium, they were "weaned" by transfer to a milkless solution, and later planted in ordinary garden soil. Dr. van Overbeek has detected evidence of the presence of at least three distinct enzymes, hormones or similar substances in coconut milk, that influence the growth of embryos. He is now investigating the chemistry of the one that seems to be most important.

Exploration of a huge crater thousands of years old, made when a massive iron projectile from interstellar space crashed into the earth, was reported by Professor E. H. Sellards, of the University of Texas. It is a funnel-shaped meteorite pit, surrounded by several smaller craters, located near the town of Odessa in western Texas. Excavations under Professor Sellards's direction are designed to demonstrate how the impact of the hurtling mass of iron-nickel smashed deep into the ground, fracturing rock layers and reducing a stratum of sandstone to fine rock flour. Geophysical prospecting methods show that the main mass of the meteorite still lies buried, 164 feet below the surface. That the Odessa craters are of considerable, though undetermined, age is proved by the discovery in the main crater of teeth and bones of the ancient native American horse, which became extinct at a date still unknown, but certainly long before the present horse population of the West was introduced by Spanish colonists.

Following the trail of America's earliest inhabitants to Alaska, where immigrants from Asia must have entered the New World long ago, Dr. Frank Hibben, of the University of New Mexico, has discovered two Folsom-like stone weapon points buried deep in the earth. These small clue objects of sharpened stone and traces of a prehistoric settlement now lying under ten feet of muck and an equal depth of peat, indicate that some ancient settlers came to southern Alaska and tarried at Cook Inlet. Dr. Hibben addressed the Geological Society of America at a special session for discussing the latest discoveries regarding early man. In the Alaskan interior where gold miners have opened up thick muck deposits near Fairbanks, Dr. Hibben has detected flint weapon points of an early American style known as the Yuma type of weapon. Such finds indicate that Paleo-Indians were present in Alaska when the last Ice Age was ending or the present era was dawning, but the scattered finds are not yet clearly fitted into the pre-history of our continent.